LEED Cost Evaluation Study

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Department of Health and Human Services
Indian Health Service
Division of Engineering Services

Table of Contents

List of Tables and Figures

Executive Summary

Background

The Indian Health Service (IHS) is responsible for the design and construction of numerous health care facilities throughout the United States. These facilities differ tremendously in terms of size, location, cost, and performance. It is the intention of the IHS to pursue concepts of sustainable design in compliance with the Federal Leadership in High Performance and Sustainable Buildings Memorandum of Understanding, the Energy Policy Act of 2005 (EPAct), and the pending DHHS Policy for Development and Operation of Sustainable, High Performance Facilities.

The simplest path to compliance with guidelines may include successful certification of IHS facilities with the U.S. Green Building Council's (USGBC) LEED® (Leadership in Energy & Environmental Design) rating system for new construction. However, the cost impacts of achieving LEED certification on IHS facilities have not yet been established.

Purpose

The purpose of this report is to evaluate the potential cost impacts of achieving Basic and/or Silver LEED certification on IHS facilities. Both initial capital investment costs and life-cycle costs (LCC) have been evaluated. This study is intended to develop realistic cost factors for the implementation of LEED certification that can be included in the IHS Facility Budget Estimating System (FBES) so that projects can be adequately funded for this purpose. Although each LEED Credit has been evaluated and grouped according to feasibility, there is no intent to prescribe a specific path of LEED credits toward certification. Every project will need to be evaluated on the basis of its program, location, and operation to determine the optimum path toward LEED certification.

Methodology

For the purposes of this study, a specific path has been chosen and certain assumptions made in order to define costs. In all cases, LEED credits have been evaluated against IHS standard practices as outlined in the A/E Design Guide. For estimation of quantities, the Sisseton Ambulatory Care Facility, currently under construction in Sisseton, SD has been utilized as a representative IHS Health Care Facility. All evaluation factors are described in greater detail within the body of the report.

Findings

The following tables identify the cost impacts for Basic and Silver LEED certification:

Initial Capital Construction Cost (does not include LCC)

	Certified		Silver	
	Low	High	Low	High
LEED Construction Cost Impacts				
Cost Impact	$170,700	$507,900	$589,700	$1,268,500
$/GSF	$2.01	$5.98	$6.95	$14.94
% Change	1.0%	3.0%	3.5%	7.6%

Table ES-1: Summary of Construction Cost Impacts

The data in table ES-1 contains costs, which would be added to the conventional construction cost. (The baseline construction cost estimate for the Sisseton ACF is $197 per square foot as designed).

Life Cycle Cost (does not include Capital Cost)

	Certified		Silver	
	Low	High	Low	High
LEED Life Cycle Cost Impacts*				
20-yr Life Cycle Cost Impacts	$ (133,300)	$ 150,500	$ (183,400)	$ 118,500
$/GSF	$ (1.57)	$ 1.77	$ (2.16)	$ 1.40

* Numbers shown in parenthesis indicate a negative life cycle cost impact, i.e. net savings as opposed to costs.

Table ES-2: Summary of 20-year Life Cycle Cost Impacts

For the purposes of this study, the life cycle cost impacts were calculated, based on a 20-year cycle. Although IHS facilities are designed for a life cycle, which exceeds this 20-year period, this study did not presume to project cost impacts beyond this duration.

Aggregate Cost (Capital and Life Cycle Cost combined)

	Certified		Silver	
	Low	High	Low	High
Aggregate Life Cycle Cost Impacts				
$/GSF	$0.44	$7.76	$4.79	$16.34
% Change	0.2%	3.9%	2.4%	8.3%

Table ES-3: Summary of Aggregate Cost Impacts

An examination of the three preceding tables suggests that energy savings over the life cycle of a facility have the potential to significantly mitigate the initial capital cost impacts. Given the potential margin of error inherent in these types of calculations, and the uncertainty of future energy prices, life cycle cost savings may completely offset or even exceed initial capital costs. As can be seen in Appendix C (Detailed Life Cycle Cost Estimates), for Credit EA1 – *Optimize Energy Performance*, the methodology used to calculate future energy costs and associated life cycle cost savings is extremely conservative.

Review of Individual Credits

To summarize the research conducted on each credit and prerequisite (65 total,) individual credit reviews are provided in this report. Each credit review sheet contains data regarding feasibility assessments, cost impact, life cycle cost impact, intent of the individual credit or prerequisite, relevant requirements, and other considerations. Additional detail regarding cost estimates, credit interpretation requests, and design calculations are contained in the appendix.

Recommendations

It is advisable for IHS to adopt LEED certification in pursuit of sustainable design and adjust project budgets accordingly. Doing so provides a measurable benchmark for determining success. LEED is widely known, has significant credibility within the private and public sectors, provides third-party validation and provides recognition for the agency, affiliated tribes, and communities. Flexibility in the LEED process facilitates multiple avenues for achieving a basic certification under disparate circumstances, site conditions, and geographic locations. Based on the analysis summarized above a 3.0% increase to the project budget is appropriate to pursue a basic LEED certification.

Introduction

Workgroup Mission

The Division of Engineering Services (DES) is responsible for managing the design and construction of all new IHS health care facilities in the U.S. In this capacity, a workgroup was commissioned on August 15, 2005, with an initial mandate to evaluate the impacts of, and estimate the costs of LEED certification using the Sisseton Ambulatory Care Facility as a basis for the cost evaluation.

The workgroup consists of six members, encompassing a wide variety of design disciplines. The workgroup consists of the following individuals:

Joseph Bermes, R.A. (Chair)*	DES-Seattle	Architect
Paul Ninomura, P.E.*	DES-Seattle	Mechanical
Hank Payne, P.E.*	DES-Seattle	Civil/Structural
Suresh Shah, P.E.	DES-Dallas	Electrical/Mechanical
Pedro Valverde, P.E.	DES-Seattle	Electrical
Michael Young, P.E.	DES-Seattle	Civil

* LEED Accredited Professional

Sustainable Design

The concept of sustainable design has been of increasing interest over the past two or more decades. The reasons are various; as population continues to grow and resources continue to diminish, there is a need to achieve a proper balance between budgetary/programmatic constraints and sustainability principles. This requires the implementation of design principles, which achieve energy efficiency and resource conservation as primary objectives. These principles are becoming widely adopted within the public sector and the private sector alike. As an example, General Services Administration (GSA) has referenced the LEED Green Building Rating System in its design standards.[1]

The concept of sustainable design is formalized through the LEED rating system, which has become the national standard for developing high-performance, sustainable buildings. This rating system was developed for some very specific purposes. These include:

- Define "green building" by establishing a common standard of measurement
- Promote integrated, whole-building design practices
- Recognize environmental leadership in the building industry
- Stimulate green competition

[1] GSA, *Facilities Standards for the Public Buildings Service* (document PBS-P100, 2003.)

- Raise consumer awareness of green building benefits
- Transform the building market

These goals are achieved through pursuit of more specific areas of performance including: state of the art strategies for sustainable site development, water savings, energy efficiency, materials selection and indoor environmental air quality.

Benefits of Sustainable (or Green) Design

As a government agency, the IHS has a responsibility to demonstrate leadership in areas of environmental stewardship. By placing a greater emphasis on sustainable design principles, the agency will be demonstrating the necessity, feasibility, and benefits of realizing these design concepts. Regardless of the larger environmental and leadership issues, the IHS stands to benefit in many ways by implementing LEED principles. Among these benefits are reduced energy usages, improved indoor environments, water savings, and positive local community impact.

According to USGBC, the construction of buildings has a heavy impact on the environment. Among these impacts are the following estimates:

- 36% of total energy use/ 65% of electricity consumption
- 30% of greenhouse gas emissions
- 30% of raw material use
- 30% of raw waste output (136 million tons per annum)
- 12% of potable water consumption

The continued use of conventional design practices will continue to negatively impact the environment by drawing excessively from non-replenishing resources (e.g. petroleum reserves, natural gas, potable water, etc.) Although current technologies do not eliminate the need for these resources, proper implementation can significantly reduce their consumption, thereby prolonging their availability through the use of rapidly renewable energy supplies and building materials.

By implementing principles of sustainable design, significant benefits can be obtained. Some of these benefits are realized immediately (e.g. energy savings, improved indoor air quality, etc,) while others are not as evident at the outset (e.g. preservation of the surrounding ecosystems, providing environmental leadership, etc.)

The USGBC has enumerated the benefits of sustainable design in four areas: environmental, economic, health and community, and productivity. These are shown in the following table.

Environmental	Economic
• Enhance and protect ecosystems and biodiversity • Improve air and water quality • Reduce solid waste • Conserve natural resources	• Reduce operating costs • Enhance asset value and profits • Improve employee productivity and satisfaction • Optimize life cycle economic performance

Health and Community	Productivity
• Improve air, thermal and acoustic environments • Enhance occupant comfort and health • Minimize strain on local infrastructure • Contribute to overall quality of life	• Improve occupant performance • Reduce absenteeism and turnover

The benefits outlined in the table above are consistent with the mission of the IHS, especially with regards to health and community.

The LEED Green Building Rating System

The LEED rating system was established by the U.S. Green Building Council as a voluntary, consensus-based national standard for developing high-performance, sustainable buildings. Several templates for LEED certifications were developed. These include: LEED-NC (New Construction,) LEED-EB (Existing Building Operations,) LEED-CI (Commercial Interiors Projects,) LEED-CS (Core and Shell,) LEED-H (Homes,) and LEED-ND (Neighborhood Development.) The applicable template for IHS is "LEED-NC." This study only investigates the requirements under this classification.

Several versions of LEED-NC have been developed. Most recently (October 2005,) version 2.2 was released. Each version is slightly modified to accommodate the latest changes in construction practices, to acknowledge acceptable alternative means to pursuing individual credits, and to provide clarity for accomplishing the intent of individual credits.

A summary of the individual credits is provided below. These credits are classified into five distinct categories: *Sustainable Sites, Water Efficiency, Energy & Atmosphere, Materials & Resources, Indoor Environmental Quality,* and *Innovation in Design*.

LEED-NC		
LEED-NC Version 2.2 Registered Project Checklist		
Sustainable Sites		14 Points
Prereq 1	**Construction Activity Pollution Prevention**	Required
Credit 1	**Site Selection**	1
Credit 2	**Development Density & Community Connectivity**	1
Credit 3	**Brownfield Redevelopment**	1
Credit 4.1	**Alternative Transportation**, Public Transportation Access	1
Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	1
Credit 4.3	**Alternative Transportation**, Low-Emitting and Fuel-Efficient Vehicles	1
Credit 4.4	**Alternative Transportation**, Parking Capacity	1
Credit 5.1	**Site Development,** Protect of Restore Habitat	1
Credit 5.2	**Site Development,** Maximize Open Space	1
Credit 6.1	**Stormwater Design,** Quantity Control	1
Credit 6.2	**Stormwater Design,** Quality Control	1
Credit 7.1	**Heat Island Effect,** Non-Roof	1
Credit 7.2	**Heat Island Effect,** Roof	1
Credit 8	**Light Pollution Reduction**	1
Water Efficiency		5 Points
Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%	1
Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	1
Credit 2	**Innovative Wastewater Technologies**	1
Credit 3.1	**Water Use Reduction**, 20% Reduction	1
Credit 3.2	**Water Use Reduction**, 30% Reduction	1
Energy & Atmosphere		17 Points
Prereq 1	**Fundamental Commissioning of the Building Energy Systems**	Required
Prereq 2	**Minimum Energy Performance**	Required
Prereq 3	**Fundamental Refrigerant Management**	Required
Credit 1	**Optimize Energy Performance**	1 to 10
Credit 2	**On-Site Renewable Energy**	1 to 3
Credit 3	**Enhanced Commissioning**	1
Credit 4	**Enhanced Refrigerant Management**	1
Credit 5	**Measurement & Verification**	1
Credit 6	**Green Power**	1
Materials & Resources		13 Points
Prereq 1	**Storage & Collection of Recyclables**	Required
Credit 1.1	**Building Reuse**, Maintain 75% of Existing Walls, Floors & Roof	1
Credit 1.2	**Building Reuse**, Maintain 100% of Existing Walls, Floors & Roof	1
Credit 1.3	**Building Reuse**, Maintain 50% of Interior Non-Structural Elements	1
Credit 2.1	**Construction Waste Management**, Divert 50% from Disposal	1
Credit 2.2	**Construction Waste Management**, Divert 75% from Disposal	1
Credit 3.1	**Materials Reuse**, 5%	1
Credit 3.2	**Materials Reuse**,10%	1
Credit 4.1	**Recycled Content**, 10% (post-consumer + ½ pre-consumer)	1
Credit 4.2	**Recycled Content**, 20% (post-consumer + ½ pre-consumer)	1
Credit 5.1	**Regional Materials**, 10% Extracted, Processed & Manufactured Regi	1
Credit 5.2	**Regional Materials**, 20% Extracted, Processed & Manufactured Regi	1
Credit 6	**Rapidly Renewable Materials**	1
Credit 7	**Certified Wood**	1
Indoor Environmental Quality		15 Points
Prereq 1	**Minimum IAQ Performance**	Required
Prereq 2	**Environmental Tobacco Smoke (ETS) Control**	Required
Credit 1	**Outdoor Air Delivery Monitoring**	1
Credit 2	**Increased Ventilation**	1
Credit 3.1	**Construction IAQ Management Plan**, During Construction	1
Credit 3.2	**Construction IAQ Management Plan**, Before Occupancy	1
Credit 4.1	**Low-Emitting Materials**, Adhesives & Sealants	1
Credit 4.2	**Low-Emitting Materials**, Paints & Coatings	1
Credit 4.3	**Low-Emitting Materials**, Carpet Systems	1
Credit 4.4	**Low-Emitting Materials**, Composite Wood & Agrifiber Products	1
Credit 5	**Indoor Chemical & Pollutant Source Control**	1
Credit 6.1	**Controllability of Systems**, Lighting	1
Credit 6.2	**Controllability of Systems**, Thermal Comfort	1
Credit 7.1	**Thermal Comfort**, Design	1
Credit 7.2	**Thermal Comfort**, Verification	1
Credit 8.1	**Daylight & Views**, Daylight 75% of Spaces	1
Credit 8.2	**Daylight & Views**, Views for 90% of Spaces	1
Innovation & Design Process		5 Points
Credit 1.1	**Innovation in Design**: Provide Specific Title	1
Credit 1.2	**Innovation in Design**: Provide Specific Title	1
Credit 1.3	**Innovation in Design**: Provide Specific Title	1
Credit 1.4	**Innovation in Design**: Provide Specific Title	1
Credit 2	**LEED® Accredited Professional**	1
Project Totals (pre-certification estimates)		69 Points
Certified 26-32 points **Silver** 33-38 points **Gold** 39-51 points **Platinum** 52-69 points		

Table 0-1: LEED-NC Registered Project Checklist

This table shows the extent of available credits, and includes the total number of points available for each. In order to achieve a certified, silver, gold, or platinum rating, the applicant must respectively earn 26-32 points, 33-38 points, 39-51, or 52-69 points. In addition to earning points, several prerequisites are applied. These include *Construction Activity Pollution Prevention, Fundamental Commissioning of the Building Energy Systems, Minimum Energy Performance, Fundamental Refrigerant Management, Storage & Collection of Recyclables, Minimum IAQ Performance,* and *Environmental Tobacco Smoke (ETS)Control.*

With a total of 69 points possible, each project can pursue LEED certification through a large variety of strategies. Because each credit must be evaluated by the USGBC, it is not advisable to seek the minimum number of credits required for a certification level. In the case of the GSA study, two bonus points were included in the analysis for each certification level in order to achieve a higher level of confidence in achieving the desired certification level.

Contents of the Study/Analysis

The IHS LEED cost study is organized into four sections, each being supported by various appendices. A general description of each section is provided as follows.

Section 1: Methodology and Scope

This section outlines the parameters for this study, including a discussion of the rationale behind these parameters. Data is provided regarding the Sisseton Ambulatory Care Facility, and factors specific to the analysis in the context of this facility are presented.

Section 2: LEED-NC v2.2 Credit Distribution

This section categorizes each of the credits available in LEED-NC v2.2 for new construction. A table of these credits is provided, including an overview of anticipated cost premiums for each applicable credit. A rough estimate for life cycle costs is also included. Finally, other feasibility factors are discussed in the context of their pertinence to the designated categories.

Section 3: Individual LEED Credit Reviews

This section includes individual credit reviews as conducted by members of the workgroup. Each credit review includes comments on feasibility, initial cost impact, life cycle cost impact, an abstract of the LEED-NC v2.2 requirement, comparison to the GSA study for each credit, and additional narrative, describing the assumptions, and design (or other) modifications required for credit achievement.

Section 4: Summary of Findings

The findings from individual credit reviews, cost analysis, life cycle cost implications, and overall feasibility are summarized. A summary of credits selected for a mock LEED application for a "Certified" rating is tabulated and compared to credits chosen for the same certification in the GSA study. Observations are elaborated upon and final recommendations and summaries are provided.

The Appendices contain a collection of pertinent information, as referenced in each section. A synopsis of the appendices is as follows:

Appendix A: Case Study: Boulder Community Foothills Hospital

A narrative of the Boulder Hospital provides information regarding the first hospital in the nation to receive LEED certification from the U.S. Green Building Council. A synopsis of specific credits utilized in the successful pursuit of this certification is provided. A discussion regarding the applicability to IHS facilities is included, highlighting key facts and information relevant to the agency's pursuit of sustainable design.

Appendix B: Detailed cost estimates for each credit

More elaborate cost data is included in this appendix. The assumptions behind each cost estimate are summarized as well.

Appendix C: Detailed Life Cycle Cost estimates for each credit

For each life cycle cost factor provided in the main text, the calculations and assumptions are shown. Methods for establishing present values are also enumerated.

Appendix D: Selected Design Scenarios and Calculations

For several of the LEED credits, specific design modifications are inherent in the application process. This appendix provides the details on design and construction elements applied for these credits. Where applicable, sketches and calculations are provided as well.

Section 1:
Methodology and Scope

Introduction

Prior to assessing the impacts of implementing LEED within the IHS facilities planning, design and construction process, it is important to acknowledge factors unique to IHS in building facilities. It is also necessary to emphasize factors, which are site-specific, and thus produce high variability with respect to cost impacts. Finally, cultural and administrative factors must be recognized in terms of potential impacts. These factors are elaborated below.

1. IHS Facilities and LEED Impacts

   Because IHS is in the business of constructing exclusively health care and health care support facilities, many of the sustainable design concepts are pursued differently than with other types of construction. For example, one of the credits available in a LEED certification process is *Brownfield Redevelopment*. In this credit, a point is earned by selecting a site that has previously been classified as having contamination present. Through assuming responsibility for the site, the owner must rectify any contamination present. In the case of petroleum contamination, this often requires a lengthy remediation process, which can include venting of gases at the surface. In a health care environment, it is imperative to eliminate any potentially harmful exposure to environmental contaminants; hence this credit is unlikely to fit the IHS model. Other credits, which are difficult to fit under a health care model include *Innovative Wastewater Technologies*, and *Water Use Reduction* (30 %.)

2. Site Specific Factors and LEED Impacts

   Because the IHS builds health care facilities in locations which are optimal for serving its clients (American Indians and Alaskan Natives,) the process of choosing a site is somewhat limiting with respect to achieving the maximum potential LEED credits in the *Sustainable Sites* category. Furthermore, the process is very unique for each facility. For example, Phoenix Indian Medical Center is located in an urban environment whereas the Winnebago Comprehensive Health Care Facility is located in a rural setting. The differences however, are much more pronounced than simply urban vs. rural environments. For example, IHS facilities in Alaska are often built in extremely remote and harsh environments while health centers in California for instance are often built in quiet communities located relatively close to urban centers.

Diversity with respect to IHS sites creates a highly variable set of possible strategies to pursue LEED credits. Hence, it must be acknowledged that no "one size fits all" approach will work across the board. Instead, it is expedient to develop a general list of credits, which are applicable in *most* cases. Other credits must be selected on the basis of site-specific factors.

3. Cultural and Administrative Factors and LEED Impacts

   IHS serves a highly diverse set of clients. The cultural factors are as disparate as the clients themselves. Thus, the strategy of pursuing sustainable design must be flexible enough to accommodate a wide variety of cultures. Furthermore, there are significant administrative factors that come into play as well. For example, many tribes have exercised their rights under Public Law 93-638 (Indian Self-Determination,) and have compacted IHS' services in many different forms. Thus, it must be recognized that despite an IHS-wide attempt to implement changes in its design and construction practices, the application of these changes is unique to the tribe, or consortium for which it is intended.

Sisseton Ambulatory Care Facility as a Basis for Evaluation

Having identified the inherent variability in application of LEED principles throughout IHS' jurisdiction, choosing a representative project was useful for the purpose of evaluation and cost analysis. To this end, the Sisseton Ambulatory Health Care Facility (ACF), which is currently under construction near Sisseton, SD, was chosen as a representative project. A rendering of the facility is provided below in figure 1-1.

Figure 1-1: Architectural Rendering of the Sisseton Ambulatory Care Facility

Currently, there are a number of facilities in the planning or design phase within the IHS' list of projects. Sisseton was chosen for this study for several reasons, which are listed as follows:

- The Sisseton ACF has already been designed, using the conventional standards as found in the IHS A/E Design Guide.
- The site is representative of many IHS facilities, in that it is located in a rural area, is relatively remote from industrial centers, does not have public transportation available, and poses unique environmental challenges to the surrounding area.
- The facility generally falls within the average size for an IHS facility, comprising approximately 85,000 GSF, is classified as a multiple occupancy ("New Business" and "New Ambulatory Health Care"), and is designed in accordance to the 2000 IBC and 2000 LSC (NFPA 101.) This is representative of many IHS facilities.
- Sisseton, South Dakota is geographically located in the Great Plains. Although a large percentage of IHS facilities are located in the southwest, the climate of the upper Great Plains represents extremes in both the winter and the summer. Hence, energy efficiency is critical throughout the year – an element of sustainable design which is vital to this study.
- Several members of the workgroup have worked extensively on this project, and therefore have a significant degree of institutional knowledge about the various factors relating to this facility. This includes site specific issues, design elements, cultural and administrative factors, and codes to which the facility has been designed.

A summary of the Sisseton ACF is provided in the following table. It includes data relevant to this study, and should be examined closely when comparing to other planned facilities in the context of the pursuit of LEED certification.

Summary of Sisseton Ambulatory Care Facility

Location	Near the City of Sisseton, in Roberts County, South Dakota
Overall Size	84,895 GSF
User Population	6,994 (Projected, 2010)
Primary Care Provider Visits	24,807 (Projected, 2010)
Outpatient Visits	49,540 (Projected, 2010)
Total Staff	198 FTEs (170 Federal, 28 Tribal)
Construction Type	Structural Steel Frame
Exterior Skin	Modular Masonry (Brick and CMU)
Construction Cost (Est.)	$16,753,370
Proximity to Roads	Adjacent to Highway 10
Sewerage	Owner to construct a gravity/forcemain extension approximately 2 miles to the City of Sisseton
Domestic Water	Owner to construct water mains to the City of Sisseton. No onsite storage to be provided.
Stormwater	Early Site Development Package included provision of an underground Stormwater detention facility, which discharges to a nearby creek.
Heating/Cooling	Basic HVAC system, per ASHRAE Std. 62-1999
Heat Exchange	Ground Source Heat Pump
Land Use	13.5 Acres, Site Area (within perimeter road) +1.1 Acres, Wellfield 14.6 Acres, Total Site Area 8.6 Acres, Landscape Area (including wellfield) 2.0 Acres, Building Footprint 3.5 Acres, Hardscape (i.e. Driveways, Parking Lots)

Table 1-1: Summary of Sisseton Ambulatory Care Facility

A site plan of the Sisseton ACF is provided below (see Figure 1-2.) The layout of all roadways, parking lots, drainage channels, landscaping, and the building footprint is evident. A collection of staff quarters will be constructed to the south of the health care facility. For the purposes of this study however, the scope is limited to the development within the perimeters of the roadways as shown.

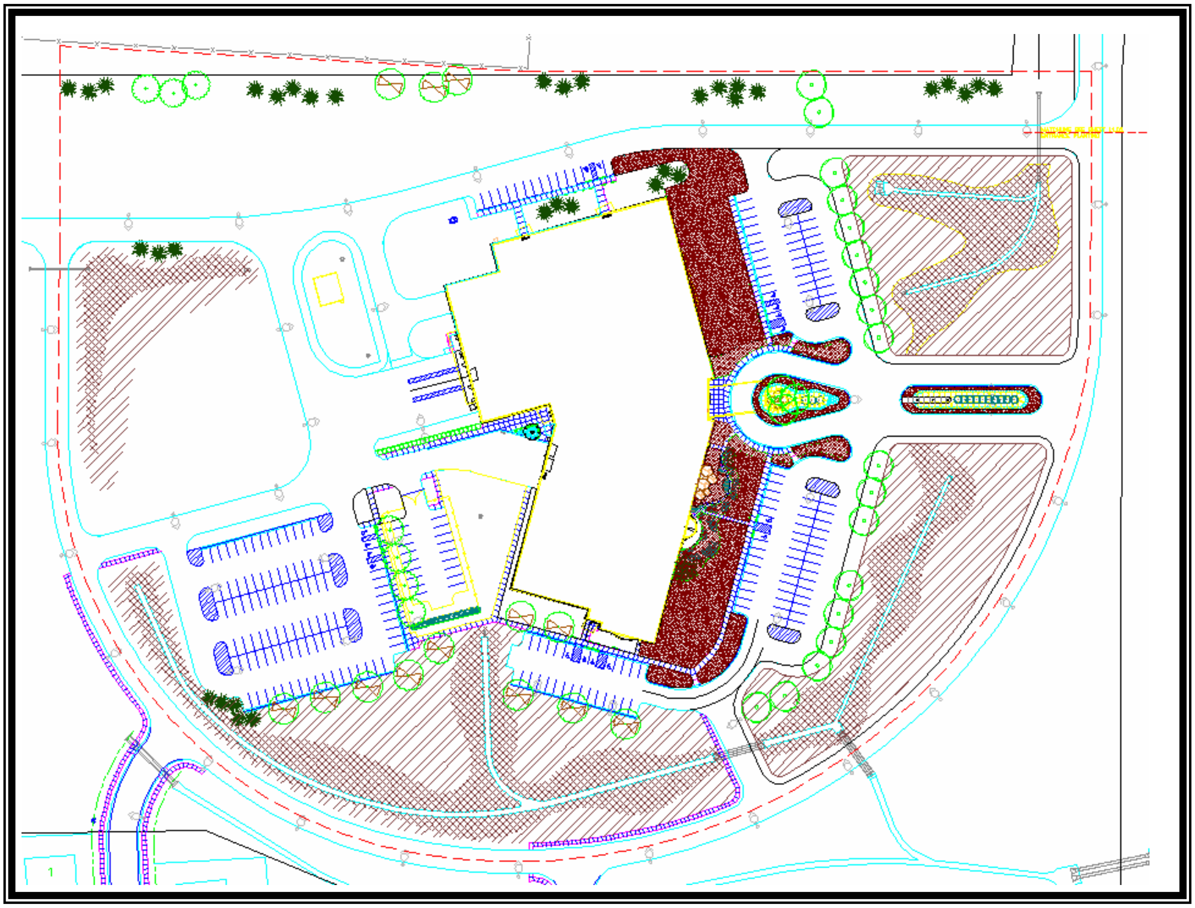

Figure 1-2: Site Plan for the Sisseton Ambulatory Care Facility

While the Sisseton ACF was chosen as a basis for evaluation, there has been no intent to pursue LEED certification in this project. The reasons are thus: the design has been completed, the budget has already been established, and the stakeholders (i.e. the Tribe, Roberts County, City of Sisseton, and the Aberdeen Area) have not been involved with any decisions to pursue this avenue of design. Therefore, the use of this facility in this study is strictly for the purpose of examining the cost impacts to pursue LEED certification.

GSA Study

In October 2004, GSA released a report, which was similar in purpose to this one. However, the scope was much larger. In order to evaluate the potential cost impacts for implementing LEED, this study examined two prototype examples (courthouse and office building modernization,) using three different LEED rating scenarios for each project ("Certified," "Silver," and "Gold" Certifications.) Furthermore, cost impacts were bracketed into two extremes: minimum cost and maximum cost. The result was a matrix of twelve different cost factors, expressed in terms of $/GSF, and as a premium to the original cost (expressed as a percentage.) This provided a tool for determining the feasibility of applying sustainable design standards to a typical GSA building.

The methodology utilized in the GSA study is consistent with the techniques used for this analysis. There are several key differences however. The IHS study for example, does not evaluate cost impacts to achieve a "Gold" Rating. Instead, the most generally achievable credits are evaluated. Whereas the GSA study examined two different construction prototypes, the IHS study only considered one (Sisseton ACF.) Finally, the IHS study examines other factors aside from initial costs. These include life cycle costs (LCC,) and general feasibility.

Despite these differences, it is expedient to compare the results. The similarities are therefore highlighted and validated. Differences between the two studies are also useful for comparison. These differences underscore the unique factors associated with IHS' construction practices and objectives. These studies are compared in Section 4 (Summary of Findings) of this paper.

Cost Estimate Qualifiers

When evaluating the cost impacts for each credit, the Sisseton facility in its current design status was taken as the baseline. From this benchmark, each credit was independently evaluated to explore the design, construction, and/or programmatic considerations required in order to fulfill the requirements. This in turn was converted into a cost estimate for each credit. Given this methodology, it is important to identify the parameters surrounding these costs, in order to properly assess the true impact of pursuing LEED credits on an individual basis. These "qualifiers" are enumerated below.

1. Although Sisseton was generally taken as a representative IHS facility, this does not necessarily mean that each cost estimate can be applied uniformly to all facility designs. For example, in the case of Sisseton, a decision was made to provide onsite Stormwater detention. Even though this is an environmentally responsible design decision, it is not necessarily standard practice on all sites. Implementation of EPA's Phase II Nonpoint Source Pollution NPDES Permit does not always require the degree of Stormwater detention, which was achieved at the Sisseton site. Hence, this study will show a *moderate* cost impact to achieve credit SS6.1 (Stormwater Design: Quantity Control,) but in many cases this credit would be very costly (>$150,000) to achieve.

2. Pursuit of a LEED "Certified" rating in the case of Sisseton led to a specific profile of credits to target. In other scenarios, the same credits might not be as cost effective to pursue. The result may be a very different cost

impact to the project. It is therefore essential to consider the applicability of the chosen credits before applying the cost factors in all cases.

3. Several of the credits selected for the Sisseton ACF were chosen because IHS' standards of design meet the requirements for those credits. Where this is the case, there is no cost impact.

4. Where building size varies significantly from the Sisseton case, the applicability of each cost factor should be moderated as well. For example, smaller facilities are likely to have a higher premium (as a percentage of total cost) for credits relating to materials and resources, as well as site factors. Conversely, larger facilities would benefit from economy-of-scale, yielding a smaller premium for similar credits.

5. Geographic factors also play an important part. One example would be access to recycling, and public transportation. Whereas Sisseton is not a feasible site for the pursuit of these credits, urban settings would be likely to achieve these credits at very little additional cost.

6. All calculations and references are expressed in English units. Although it is customary to use SI units on IHS projects, the LEED manual uses English units.

Section 2:
LEED-NC v2.2 Credit Distributions

Introduction

In the context of IHS facilities, it is useful to categorize the assortment of all 58 credits and 7 prerequisites. Using the Sisseton ACF as a basis for evaluation, each credit was studied independently, and categorized accordingly. Each category was developed as a result of several iterations of credit evaluations. When considering each category, emphasis was placed on providing a tool useful in two ways: 1) establishing a hierarchy for choosing the most desirable credits, and 2) providing flexibility for unique design parameters, such that all potential credits would be considered for each case. Aside from these purposes, it was also expedient to develop categories, which capture other factors, such as prerequisites, and non-construction related credits.

Basis for Credit Designation

In order to form the array of credit designations, seven special categories were defined to recognize subjective factors, such as categorical requirements (i.e. prerequisites,) situational credits (applicability is specific to each project,) etc. For the remaining credits, an objective strategy was applied to further categorize the credits in terms of cost impacts, and overall feasibility.

The result of this strategy was the following array of categories for designating each LEED credit:

Category	Description	Purpose
1.	LEED Prerequisites	To acknowledge which requirements must be met under all circumstances.
2.	Mandate or Standard Practice	Identifies credits, which are currently met under existing IHS design standards and practices.
3.	High Feasibility	Highlights those credits, which are reasonably inexpensive to achieve, and do not interfere with the purpose of IHS facilities.

4.	Moderate Feasibility	Identifies credits which can be achieved, but involve additional costs, or may not be as feasible for IHS functions.
5.	Low Feasibility	Identifies which credits are significantly difficult to achieve, due to programmatic or budgetary constraints.
6.	Situational Feasibility	Highlights credits, which may be feasible, depending on geographic, cultural, or site-specific factors.
7.	Non-Construction Related Feasibility	Categorizes those credits, which require efforts aside from design and/or construction modifications.

Table 2-1: List of Categories for Designation of LEED Credits

Data Contained in the Credit Groupings

Table 2-2 (shown on the following page) contains a summary of the credit groupings/designations as discussed above. Also included in this table is a listing of the anticipated capital cost impacts and life cycle cost impacts. To accommodate the multiple avenues for achieving some credits, as well as the uncertainty of some cost impacts, a range of costs is provided. This serves to bracket the costs, rather than presenting a single number. Where greater uncertainty exists or where options are numerous, a larger range is listed on the table. The "points" column shows the number of points that would be earned through successfully completing the requirements for each credit. Since some credits offer more than one point, it is important to track them here.

The final column contains an array of percentages, which represent the statistical frequency of each credit, as referenced in a study provided by Davis Langdon[1] This study summarizes the efforts to pursue LEED certification from nearly 600 distinct projects in 19 different states, encompassing a wide variety of building types, locations, sizes, and programs. It is generally observed that those credits designated by this study as "High Feasibility" are popularly pursued in the referenced study. Furthermore, most credits designated under "Low Feasibility" generally are shown to be scarcely pursued by the projects referenced in the Langdon paper.

[1] *Costing Green: A Comprehensive Cost Database and Budgeting Methodology,* Lisa Fay Matthiessen and Peter Morris (Davis Langdon), July 2004

Summary of IHS LEED® Credit Groupings

Credit	Description	Capital Cost Impact Low	Capital Cost Impact High	LCC Impact Low	LCC Impact High	Pts	Langdon Study
Tier 1: Prerequisites							
SSPR1	Construction Activity Pollution Prevention	$0	$0	$0	$0	-	-
EAPR1	Fundamental Commissioning of the Building Energy Systems	$18,000	$22,000	$0	$0	-	-
EAPR2	Minimum Energy Performance	$0	$0	$0	$0	-	-
EAPR3	Fundamental Refrigerant Management	$0	$0	$0	$0	-	-
MRPR1	Storage & Collection of Recyclables	$0	$46,000	$5,700	$70,500	-	-
EQPR1	Minimum IAQ Performance	$0	$0	$0	$0	-	-
EQPR2	Environmental Tobacco Smoke (ETS) Control	$0	$0	$0	$0	-	-
	Total, Prerequisites:	**$18,000**	**$68,000**	**$5,700**	**$70,500**	**-**	
Tier 2: Mandate or Standard Practice							
EA1(1)	Optimize Energy Performance (First Two Points; See Note 2. Below)	$0	$0	$0	$0	2	94%
EQ7.1	Thermal Comfort, Design	$0	$0	$0	$0	1	78%
ID2	LEED® Accredited Professional	$0	$0	$0	$0	1	97%
WE1.1	Water Efficient Landscaping, Reduce by 50%	$7,900	$13,100	$9,200	$21,000	1	83%
WE1.2	Water Efficient Landscaping, No Potable Use or No Irrigation	$0	$45,000	-$21,900	$48,200	1	16%
	Total, Mandate or Standard Practice:	**$7,900**	**$58,100**	**-$12,700**	**$69,200**	**6**	**74%**
Tier 3: High Feasibility							
EA1(2)	Optimize Energy Performance (Points 3-5; See Note 2. Below)	$20,000	$40,000	-$82,800	-$61,200	3	50%
SS4.2	Alternative Transportation, Bicycle Storage & Changing Rooms	$0	$1,200	$0	$0	1	80%
SS4.4	Alternative Transportation, Parking Capacity	$0	$0	$0	$0	1	58%
EQ4.1	Low-Emitting Materials, Adhesives & Sealants	$0	$1,600	$0	$0	1	100%
EQ4.2	Low-Emitting Materials, Paints & Coatings	$0	$21,100	$0	$0	1	95%
EQ4.3	Low-Emitting Materials, Carpet Systems	$0	$14,300	$0	$0	1	91%
SS7.2	Heat Island Effect, Roof	$22,500	$27,500	-$9,200	-$5,500	1	42%
ID1.4	Innovation in Design: SS7.2-SRI 78 for 100% of roof surface	$0	$0	$0	$0	1	0%
SS8	Light Pollution Reduction	$0	$13,000	$0	$0	1	61%
EA5	Measurement & Verification	$3,000	$8,000	$3,700	$15,000	1	24%
EQ1	Outdoor Air Delivery Monitoring	$3,000	$3,600	$700	$1,200	1	52%
EQ2	Increased Ventilation	$2,000	$5,000	$14,300	$47,700	1	16%
EQ3.1	Construction IAQ Management Plan, During Construction	$300	$1,500	$0	$0	1	95%
EQ3.2	Construction IAQ Management Plan, Before Occupancy	$1,000	$3,000	$0	$0	1	88%
EQ5	Indoor Chemical & Pollutant Source Control	$1,300	$11,000	$1,200	$2,500	1	64%
EQ6.1	Controllability of Systems, Lighting	$0	$10,000	$0	$0	1	25%
EQ7.2	Thermal Comfort, Verification	$0	$0	$1,000	$2,000	1	24%
	Total, High Feasibility:	**$53,100**	**$160,800**	**-$71,100**	**$1,700**	**19**	**59%**
Tier 4: Moderate Feasibility							
EA1(3)	Optimize Energy Performance (Points 6-7; See Note 2. Below)	$30,000	$60,000	-$55,200	-$40,800	2	20%
SS6.1	Stormwater Design, Quantity Control	$0	$83,500	$0	$49,900	1	34%
SS7.1	Heat Island Effect, Non-Roof	$120,000	$143,400	-$11,800	-$7,100	1	62%
EA3	Enhanced Commissioning	$16,700	$22,500	$0	$0	1	43%
EQ4.4	Low-Emitting Materials, Composite Wood & Agrifiber Products	$0	$159,900	$0	$0	1	41%
EA4	Enhanced Refrigerant Management	$5,000	$20,000	$5,600	$7,500	1	58%
MR4.1	Recycled Content, 10% (post-consumer + ½ pre-consumer)	$0	$27,900	$0	$0	1	94%
MR5.1	Regional Materials, 10% Extracted, Processed & Manufactured Regionally	$0	$50,000	$0	$0	1	97%
EA2(1)	On-Site Renewable Energy (First Two Points)	$294,000	$359,400	-$43,900	-$32,400	2	8%
	Total, Moderate Feasibility:	**$465,700**	**$926,600**	**-$105,300**	**-$22,900**	**11**	**56%**
Tier 5: Low Feasibility							
EA1(4)	Optimize Energy Performance (Points 8-10; See Note 2. Below)	-	-	-$82,800	-$61,200	3	0%
WE3.1	Water Use Reduction, 20% Reduction	-	-	-	-	1	80%
WE2	Innovative Wastewater Technologies	$43,000	$53,000	$58,000	$71,000	1	5%
WE3.2	Water Use Reduction, 30% Reduction	-	-	-	-	1	10%
MR3.1	Materials Reuse, 5%	-	-	$0	$0	1	3%
MR4.2	Recycled Content, 20% (post-consumer + ½ pre-consumer)	-	-	$0	$0	1	17%
MR5.2	Regional Materials, 20% Extracted, Processed & Manufactured Regionally	-	-	$0	$0	1	3%
MR6	Rapidly Renewable Materials	-	-	-	-	1	8%
MR7	Certified Wood	-	-	$0	$0	1	30%
EQ6.2	Controllability of Systems, Thermal Comfort	-	-	-	-	1	4%
EQ8.1	Daylight & Views, Daylight 75% of Spaces	-	-	-	-	1	33%
EQ8.2	Daylight & Views, Views for 90% of Spaces	-	-	$0	$0	1	53%
ID1.3	Innovation in Design: SS7.1-100% Hardscape meets requirements	$240,000	$286,800	-$11,800	-$7,100	1	7%
MR3.2	Materials Reuse,10%	-	-	$0	$0	1	0%
MR2.1	Construction Waste Management, Divert 50% from Disposal	-	-	$0	$0	1	100%
MR2.2	Construction Waste Management, Divert 75% from Disposal	-	-	$0	$0	1	72%
EA2(2)	On-Site Renewable Energy (Final Point)	-	-	-	-	1	0%
	Total, Low Feasibility:	**$283,000**	**$339,800**	**-$36,600**	**$2,700**	**19**	**25%**
Tier 6: Situational							
SS1	Site Selection	$24,000	$105,000	$0	$0	1	84%
SS2	Development Density & Community Connectivity	-	-	$0	$0	1	8%
SS4.1	Alternative Transportation, Public Transportation Access	-	-	$0	$0	1	75%
SS5.2	Site Development, Maximize Open Space	$0	$0	$0	$0	1	34%
ID1.2	Innovation in Design: SS5.2-Provide 2x Bldg Footprint as open space	$0	$0	$0	$0	1	30%
SS3	Brownfield Redevelopment	$44,000	$330,000	$0	$143,300	1	3%
SS6.2	Stormwater Design, Quality Control	$70,000	$124,300	$0	$27,800	1	46%
SS5.1	Site Development, Protect of Restore Habitat	$0	$21,000	$0	$0	1	36%
ID1.1	Innovation in Design: SS5.1-Restore 75% of Site	$18,000	$21,000	$0	$0	1	66%
MR1.1	Building Reuse, Maintain 75% of Existing Walls, Floors & Roof	-	-	$0	$0	1	5%
MR1.2	Building Reuse, Maintain 100% of Existing Walls, Floors & Roof	-	-	$0	$0	1	3%
MR1.3	Building Reuse, Maintain 50% of Interior Non-Structural Elements	-	-	$0	$0	1	0%
	Total, Situational:	$156,000	$601,300	$0	$171,100	**12**	33%
Tier 7: Non-Construction							
SS4.3	Alternative Transportation, Low-Emitting and Fuel-Efficient Vehicles	$21,000	$26,000	-$18,600	$0	1	10%
EA6	Green Power	-	-	-	-	1	7%
	Total, Non-Construction:	$21,000	$26,000	-$18,600	$0	2	9%

Notes

1. "Langdon Study" refers to a study, which referenced the frequency of building projects achieving a particular credit, when pursuing a LEED "certified" level

2. The Energy Policy Act of 2005 will promulgate energy practices within IHS, to exceed ASHRAE 90.1 by 30%. This will earn six points for this LEED credit. For the purposes of this study however, the credits are divided into different tiers (more conservative.)

Summary of First Four Tiers (as a % of total Construction Cost)	Cap. Cost Range		% of Tot.	Points
Prerequisites	$18,000	$68,000	0.1 to 0.4	0
Mandate or Standard Practice	$7,900	$58,100	0.0 to 0.3	6
High Feasibility	$53,100	$160,800	0.3 to 1.0	19
Moderate Feasibility	$465,700	$926,600	2.8 to 5.5	11
Total	**$544,700**	**$1,213,500**	**3.3 to 7.2**	**36**

Table 2-2: Credit Categorization Matrix, including capital and life cycle cost impacts

Discussion of Table 2-2

Table 2-2 is a comprehensive tool, intended to be used as a mechanism for evaluating the most desirable credits for selection when pursuing a LEED certification. It should be stressed however, that it is not intended to supersede the evaluation process of a team of architects and engineers, seeking a strategy for implementing LEED certification. This table is analogous to a map, which contains information useful to an informed reader. A map does not provide specific directions, nor does it provide every detail, but is a useful tool for determining the best route(s) to take. Similarly, this table should be used as a means for sorting through the profusion of data in a relatively short period of time. This will enable the user to chart a prudent course for pursuing LEED certification.

Ground Source Heat Pump. Whereas the Sisseton Ambulatory Care Facility was chosen because it signifies a representative IHS facility in many ways, one significant unique feature remains – a ground-source heat pump. This is significant as it pertains to credit EA1 (Optimize Energy Performance.) If this credit only scored one point, it could be casually disregarded. However, it presents a possibility of as many as ten (10) points. For this reason, the approach for dealing with this credit was significantly different. As the facility is designed, it will provide an estimated energy savings of 32% (over ASHRAE 90.1-2004 requirements.) This would qualify for seven points under the credit. Because this study is intended to provide a conventional design as a benchmark for a basis of cost impacts, the credit was divided between the different categories. Specifically, it was distributed as follows:

- First Two Points: *Mandate or Standard Practice*
- Points 3-5: *High Feasibility*
- Points 6-7: *Moderate Feasibility*
- Points 8-10: *Low Feasibility*

On-Site Renewable Energy. Given that credit EA2, *On-Site Renewable Energy* contains three possible points; it was parsed in a similar fashion: the first two points are covered under *Moderate Feasibility*, and the final point is under *Low Feasibility*.

Cost Estimates. Only the first four tiers contain cost data for every credit. The remaining three tiers are lacking data, because these are not likely to be pursued in the majority of IHS projects. However, credits for which cost data has not been developed should not be discounted when evaluating a project for LEED certification. Specific project circumstances may increase the feasibility of these types of credits.

Life Cycle Costs. Life cycle costs look at long-term impacts to a design option. For consistency, all credits were evaluated for a life cycle of 20 years, and a discount/interest rate of 5% was used. All projected future costs within this time cycle are converted to a present value. The present value represents the total life cycle cost in terms of today's dollars. This enables life cycle costs to be assessed with capital investment on a comparative basis. Although capital costs are often included in the life cycle cost calculation, these are listed separately in table 2-2, so that these can be compared uniquely in terms of capital costs only.

Aggregate Life Cycle Costs. In Table 2-2, cost values are summarized in terms of *capital cost*, and *life cycle cost*. In many cases, the life cycle costs are actually determined to be life cycle savings. In order to identify the impact that potential life cycle savings would have on the overall cost, these costs are combined in table 2-3. Because life cycle costs (in table 2-2) are expressed in present value dollars, they can be combined with capital costs to get an *aggregate life cycle cost* for each credit.

Although it is standard practice to express life cycle costs in such a manner, the reality of funding cycles and budgets may create a different scenario when applying life cycle savings to a facility. In other words, budget constraints may preclude developing energy savings technology, even though life cycle costs would justify the additional investment at the outset of the project.

Summary of Aggregate Life Cycle Costs
First Four Tiers

		Aggregate LCC Impact Low	Aggregate LCC Impact High	Points
Tier 1: Prerequisites				
SSPR1	Construction Activity Pollution Prevention	$0	$0	-
EAPR1	Fundamental Commissioning of the Building Energy Systems	$18,000	$22,000	-
EAPR2	Minimum Energy Performance	$0	$0	-
EAPR3	Fundamental Refrigerant Management	$0	$0	-
MRPR1	Storage & Collection of Recyclables	$5,700	$116,500	-
EQPR1	Minimum IAQ Performance	$0	$0	-
EQPR2	Environmental Tobacco Smoke (ETS) Control	$0	$0	-
	Total, Prerequisites:	**$23,700**	**$138,500**	-
Tier 2: Mandate or Standard Practice				
EA1(1)	Optimize Energy Performance (First Two Points; See Note 2. Below)	$0	$0	2
EQ7.1	Thermal Comfort, Design	$0	$0	1
ID2	LEED® Accredited Professional	$0	$0	1
WE1.1	Water Efficient Landscaping, Reduce by 50%	$17,100	$34,100	1
WE1.2	Water Efficient Landscaping, No Potable Use or No Irrigation	-$21,900	$93,200	1
	Total, Mandate or Standard Practice:	**-$4,800**	**$127,300**	**6**
Tier 3: High Feasibility				
EA1(2)	Optimize Energy Performance (Points 3-5; See Note 2. Below)	-$62,800	-$21,200	3
SS4.2	Alternative Transportation, Bicycle Storage & Changing Rooms	$0	$1,200	1
SS4.4	Alternative Transportation, Parking Capacity	$0	$0	1
EQ4.1	Low-Emitting Materials, Adhesives & Sealants	$0	$1,600	1
EQ4.2	Low-Emitting Materials, Paints & Coatings	$0	$21,100	1
EQ4.3	Low-Emitting Materials, Carpet Systems	$0	$14,300	1
SS7.2	Heat Island Effect, Roof	$13,300	$22,000	1
ID1.4	Innovation in Design: SS7.2-SRI 78 for 100% of roof surface	$0	$0	1
SS8	Light Pollution Reduction	$0	$13,000	1
EA5	Measurement & Verification	$6,700	$23,000	1
EQ1	Outdoor Air Delivery Monitoring	$3,700	$4,800	1
EQ2	Increased Ventilation	$16,300	$52,700	1
EQ3.1	Construction IAQ Management Plan, During Construction	$300	$1,500	1
EQ3.2	Construction IAQ Management Plan, Before Occupancy	$1,000	$3,000	1
EQ5	Indoor Chemical & Pollutant Source Control	$2,500	$13,500	1
EQ6.1	Controllability of Systems, Lighting	$0	$10,000	1
EQ7.2	Thermal Comfort, Verification	$1,000	$2,000	1
	Total, High Feasibility:	**-$18,000**	**$162,500**	**19**
Tier 4: Moderate Feasibility				
EA1(3)	Optimize Energy Performance (Points 6-7; See Note 2. Below)	-$25,200	$19,200	2
SS6.1	Stormwater Design, Quantity Control	$0	$133,400	1
SS7.1	Heat Island Effect, Non-Roof	$108,200	$136,300	1
EA3	Enhanced Commissioning	$16,700	$22,500	1
EQ4.4	Low-Emitting Materials, Composite Wood & Agrifiber Products	$0	$159,900	1
EA4	Enhanced Refrigerant Management	$10,600	$27,500	1
MR4.1	Recycled Content, 10% (post-consumer + ½ pre-consumer)	$0	$27,900	1
MR5.1	Regional Materials, 10% Extracted, Processed & Manufactured Regionally	$0	$50,000	1
EA2(1)	On-Site Renewable Energy (First Two Points)	$250,100	$327,000	2
	Total, Moderate Feasibility:	**$360,400**	**$903,700**	**11**

Table 2-3: Summary of Aggregate Life Cycle Costs (First Four Tiers only)

Discussion of Table 2-3

A review of table 2-3 shows that, in terms of a comprehensive approach, anticipated savings over the long term will not necessarily offset capital cost investment. In some cases, aggregate life cycle costs exceed capital costs substantially. Despite the overall assessment of the first four tiers, it must be recognized that a substantial percentage of the aggregate life cycle impacts is due to a small group of credits, namely: EA2 Onsite Renewable Energy (25%), SS7.1 Heat Island Effect – non Roof (10%), MRPR1 Storage and Collection of Recyclables (10%), and SS6.1 Stormwater Design – Quantity Control (10%.) These four credits combined, account for 50% of the total aggregate life cycle cost as represented in the first four tiers.

Significant savings could be realized, if site-specific factors could allow credits from tier six (6) to be pursued in lieu of the more expensive credits shown on table 2-3.

It is worthwhile to note that the Energy and Atmosphere Credit 1 (EA1) credits show potential aggregate LCC savings on the low estimates, even up to points 6 and 7. This suggests that an aggressive strategy of energy savings is worth the investment as it would realize a payoff in less than 20 years.

As table 2-3 only addresses monetary impacts, it is important to note that additional non-economic benefits would be realized through LEED certification, as well. For example, a Stormwater abatement program would protect the local environment by preventing erosion and protecting the nearby stream from any adverse impacts.

Also not considered in Life Cycle Cost calculations is the economic benefit resulting from increased productivity and a reduction in sick leave days taken by employees. This is one of several benefits anticipated through improvements to indoor environmental quality, such as improved ventilation & lighting, as well as control of indoor air contaminants.

Section 3:
Individual Credit Reviews

Introduction

This section presents the individual credit reviews. As each credit was evaluated for this report, points of significance were identified and documented. The purpose for this process was to provide detailed notation for each credit, thereby offering a quick reference for individuals seeking specific information. Through this evaluation process, the individuals performing each review were able to:

1. Identify the applicability of a particular credit to the mission of IHS facility construction and ascertain whether a credit posed unique challenges, or was categorically infeasible.
2. Summarize the anticipated cost impacts of pursuing an individual credit. Using the existing design at Sisseton as the baseline, any necessary modifications to achieve the credit are identified and estimated for cost. Where more than one design modification could be used to achieve the credit, several cost estimates are developed. Using the highest and lowest cost estimates, a cost range is established.
3. Examine the anticipated life cycle cost impact for pursuing a credit. Where applicable, cost savings are documented as a negative life cycle cost. For the sake of uniformity, the parameters for each life cycle are identical (i.e. 5% inflation/discount rate, 20-yr life cycle.)
4. Provide specific documentation regarding variables unique to each credit. Due to the wide range of issues that are presented in each credit, distinct notes are offered to notify the reader of the options available, and the credit interpretation issues which may be raised.

Description of Data Fields

The data presented in each credit review is presented in a unified format. This provides a familiar template, thus enabling the reader to quickly assimilate information which is pertinent to specific credits. A description of each data field is provided below:

1. **LEED Prerequisite or Credit Title.** Self explanatory.
2. **Feasibility.** Due to the specific nature of IHS facilities, this field provides a quick narrative, identifying where the LEED template presents special challenges or in some cases, does not apply to IHS construction.

3. **Initial Cost Impact.** Contains a concise description, categorizing anticipated costs (e.g. none, low, moderate, high, variable, N/A.)
4. **Capital Cost Impact Rating.** Displays a bar chart, identifying the anticipated cost range (e.g. mandate or standard practice, $0-5K, $5K-$50K, $50K-$150K, >$150K.)
5. **Life Cycle Cost Impact.** Similar to initial cost impact, this contains a brief comment regarding anticipated impacts over the life cycle of the building.
6. **Life Cycle Cost Impact Rating.** A bar chart displays anticipated life cycle cost impacts (e.g. Potential Savings, $0-$5K, $5K-$50K, $50K-$150K, >$150K.)
7. **Intent.** A narrative outlines the purpose for the credit, including the environmental benefits anticipated.
8. **Relevant Requirements.** A quick summary is provided of the specific requirements, as determined by the US Green Building Council.
9. **GSA Study Conclusions.** A comparison is given to the GSA LEED study, and noteworthy observations or comments are presented.
10. **Other Considerations.** Where applicable, unique information is shared with reference to credit interpretation requests, special considerations, or IHS-specific issues.
11. **Cost Estimate Data.** Where applicable, the premises for developing cost estimates are given here, and the range of costs is provided; the actual tabulation of cost estimates is enumerated in the appendix.

<u>Suggestions for Using this Data</u>

The following credit reviews are intended to be used as a starting point in the process of selecting credits to pursue. The actual process of application for LEED credits requires an elaborate submittal process. Furthermore, because the LEED template was applied to one facility only (Sisseton,) the applicability of each credit review will not apply for every IHS facility. Hence, this data should be interpreted accordingly.

It is advised that the information gathered from this section be reviewed jointly with the credit categorization matrix, provided in Table 2-2. This will assist the planning and design process such that a prioritization of credits can be developed along with general information regarding these credits. Beyond this process, the details will emerge as the process of LEED certification begins.

Sustainable Sites Prerequisite 1: Erosion and Sedimentation Control

Feasibility: Standard Practice.

Initial Cost Impact: None

Mandate or Standard Practice	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Life-Cycle Cost Impact: None

Potential Savings	**$0 - $5K**	$5K - $50K	$50K - $150K	>$150K

Intent: Reduce pollution from construction activities by controlling soil erosion, waterway sedimentation and airborne dust generation.

Relevant Requirements: Implement an Erosion and Sediment Control (ESC) Plan for all construction activities in accordance with the 2003 EPA Construction General Permit meeting the following objectives:

1. Prevent loss of soil during construction by stormwater runoff and/or wind erosion.
2. Protect topsoil by stockpiling for reuse.
3. Prevent sedimentation of storm sewer or receiving streams.
4. Prevent polluting the air with dust.

GSA Study Conclusions: No cost impact. Requirements generally met through standard practices.

Other Considerations: None.

Cost Estimates: N/A

Sustainable Sites Credit 1: Site Selection

Feasibility: Situational – Could be implemented as a criterion in Site Selection process, but compliance cannot be guaranteed.

Initial Cost Impact: Depends on the Available Sites.

Mandate or Standard Practice	$0 - $5K	**$5K - $50K**	**$50K - $150K**	>$150K

Life-Cycle Cost Impact: None.

Potential Savings	**$0 - $5K**	$5K - $50K	$50K - $150K	>$150K

Intent: Avoid development of inappropriate sites and reduce the environmental impact from the location of a building on a site.

Relevant Requirements: Do not develop buildings, hardscape, roads or parking on portions of sites that meet following criteria:

1. Prime farmland.
2. Previously undeveloped land whose elevation is lower than 5 feet above the 100-year flood elevation.
3. Land identified as habitat for threatened or endangered species.
4. Within 100 feet of wetlands.
5. Previously undeveloped land within 50 feet of a water body.
6. Public Parkland.

GSA Study Conclusions: No cost impact – Site selection beyond scope of study.

Other Considerations: None.

Cost Estimates:

Cost impact would entail difference in price of land within city limits of Sisseton (due to preponderance of prime farmland in the county,) and the land purchased for this project.

Capital Cost: $24,000 - $105,000

Life Cycle Cost: None

Sustainable Sites Credit 2: Development Density & Community Connectivity

Feasibility: Situational – Could be implemented as a criterion in Site Selection process, but compliance can not be guaranteed, and would be impractical to achieve in most cases due to the rural nature of most IHS projects.

Initial Cost Impact: None.

Mandate or Standard Practice	**$0 - $5K**	$5K - $50K	$50K - $150K	>$150K

Life-Cycle Cost Impact: None.

Potential Savings	**$0 - $5K**	$5K - $50K	$50K - $150K	>$150K

Intent: Channel development to urban areas with existing infrastructure, protect greenfields and preserve habitat and natural resources.

Relevant Requirements:

> Option 1: Construct on previously developed sites within a community with a minimum density of 60,000 SF per acre (two-story downtown).
>
> Option 2: Construct on previously developed sites within ½ mile of a residential neighborhood with an average density of 10 units pre acre and within ½ mile of at least 10 basic services (Bank, Place of Worship, Convenience Grocery, Day Care, Cleaners, Fire Station, Beauty, Hardware, Laundry, Library, Medical/Dental, etc.).

GSA Study Conclusions: No cost impact – Most GSA sites comply with Option 1.

Other Considerations: None.

Cost Estimates: N/A

Sustainable Sites Credit 3: Brownfield Redevelopment

Feasibility: Situational – Could be implemented as a criterion in Site Selection process, but compliance can not be guaranteed.

Initial Cost Impact: Highly Variable; Situational

Mandate or Standard Practice	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Life-Cycle Cost Impact: None

Potential Savings	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Intent: Rehabilitate damaged sites where development is complicated by environmental contamination, reducing pressure on undeveloped land.

Relevant Requirements: Develop on a site documented as contaminated. Remediate contamination prior to development.

GSA Study Conclusions: No cost impact – Site selection beyond scope of study.

Other Considerations: None.

Cost Estimates:

Assume two scenarios to develop cost range: 1) “Maximum” Cost: 5,000 CY requiring offsite treatment and backfilling, 2) “Minimum” Cost: Onsite treatment (windrowing,) of 1000 CY.

Capital Cost: $44,000 - $330,000

Life Cycle Cost: $0 - $143,300

Sustainable Sites Credit 4.1: Alternative Transportation, Public Transportation Access

Feasibility: Situational – Could be implemented as a criterion in Site Selection process, but compliance can not be guaranteed, and would be impractical to achieve in most cases due to the rural nature of most IHS projects.

Initial Cost Impact: None, but requires access.

Mandate or Standard Practice	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Life-Cycle Cost Impact: None

Potential Savings	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Intent: Reduce pollution and land development impacts from automobile use.

Relevant Requirements: Locate project within ½ mile of an existing – or planned and funded – commuter rail, light rail or subway station, or within ¼ mile of one or more stops for two or more public bus line stops.

GSA Study Conclusions: No cost impact – Most GSA sites comply.

Other Considerations:

Additional credit is available under Innovation & Design by instituting a comprehensive management plan that demonstrates a quantifiable reduction in personal automobile use through multiple alternative options.

Cost Estimates: N/A

Sustainable Sites Credit 4.2: Alternative Transportation, Bicycle Storage & Changing Rooms

Feasibility: High – IHS employee facilities typically provide adequate changing and shower rooms. Bicycle racks can be provided at insignificant cost to project.

Initial Cost Impact: Very little.

Mandate or Standard Practice	**$0 - $5K**	$5K - $50K	$50K - $150K	>$150K

Life-Cycle Cost Impact: None

Potential Savings	**$0 - $5K**	$5K - $50K	$50K - $150K	>$150K

Intent: Reduce pollution and land development impacts from automobile use.

Relevant Requirements: Provide secure bicycle racks and/or storage for 5% of all building users, and provide shower and changing facilities for 0.5% of all FTE occupants.

GSA Study Conclusions: High premium – most GSA projects do not include shower and changing facilities.

Other Considerations:

Additional credit is available under Innovation & Design by instituting a comprehensive management plan that demonstrates a quantifiable reduction in personal automobile use through multiple alternative options.

Cost Estimates:

Assume that two small rooms would be available for this purpose without adding space.

Capital Cost: $0 - $1,200

Life Cycle Cost: None

Sustainable Sites Credit 4.3: Alternative Transportation, Low-Emission & Fuel Efficient Vehicles

Feasibility: Non-Construction – This credit could be achieved by providing hybrid gas/electric vehicles in the Service Unit motor pool fleet (Option 1).

Initial Cost Impact: Moderate.

Mandate or Standard Practice	$0 - $5K	**$5K - $50K**	$50K - $150K	>$150K

Life-Cycle Cost Impact: Potential Savings.

Potential Savings	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Intent: Reduce pollution and land development impacts from automobile use.

Relevant Requirements:

Option 1: Provide low-emitting and fuel-efficient vehicles for 3% of FTE occupants and preferred parking for these vehicles.

Option 2: Provide preferred parking for low-emitting and fuel-efficient vehicles for 5% of total parking capacity of site.

Option 3: Install alternative-fuel refueling stations for 3% of the total parking capacity of the site.

GSA Study Conclusions: Low premium (<$50K) – Solution included installation of alternative-fuel refueling stations as per Option 3.

Other Considerations:

Additional credit is available under Innovation & Design by instituting a comprehensive management plan that demonstrates a quantifiable reduction in personal automobile use through multiple alternative options.

Cost Estimates:

Preferred Parking could be designated through incidental painting; Cost difficult to attribute to construction, as it would require a programmatic change to use hybrid cars in the motor pool.

Life Cycle Cost: ($6,900) - $0

Sustainable Sites Credit 4.4: Alternative Transportation, Parking Capacity

Feasibility: High – As there are typically no local zoning parking requirements on IHS projects, a CIR would be necessary to confirm that credit is met by not exceeding POR calculation for minimum parking capacity.

Initial Cost Impact: None.

Mandate or Standard Practice	**$0 - $5K**	$5K - $50K	$50K - $150K	>$150K

Life-Cycle Cost Impact: None

Potential Savings	**$0 - $5K**	$5K - $50K	$50K - $150K	>$150K

Intent: Reduce pollution and land development impacts from automobile use.

Relevant Requirements: Size parking capacity to not exceed minimum local zoning requirements, and provide preferred parking for carpools for 5% of total provided parking spaces.

GSA Study Conclusions: Low premium (<$50K) – Nominal costs associated with providing preferred parking designation.

Other Considerations:

Additional credit is available under Innovation & Design by instituting a comprehensive management plan that demonstrates a quantifiable reduction in personal automobile use through multiple alternative options.

Cost Estimates:

Inasmuch as IHS typically does not fall under a city or county jurisdiction, its own parking density regulations apply. Since IHS does not typically exceed its number of allotted parking spaces, this credit can be earned without additional design or construction processes, and hence, no additional cost.

Capital Cost: None

Life Cycle Cost: None

Sustainable Sites Credit 5.1: Site Development, Protect or Restore Habitat

Feasibility: Moderate – IHS project sites are often large enough to allow restoration of 50% with native vegetation. Requires additional consideration during landscape design.

Initial Cost Impact: Low to Moderate.

Mandate or Standard Practice	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Life-Cycle Cost Impact: None

Potential Savings	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Intent: Conserve existing natural area and restored damaged areas to provide habitat and promote biodiversity.

Relevant Requirements: On previously developed sites (including farmland), restore a minimum of 50% of the site area (excluding building footprint) with native or adapted vegetation.

GSA Study Conclusions: No premium – Possible savings as landscaping is generally less expensive than paving.

Other Considerations:

Additional credit is available under Innovation & Design if 75% of the site area is restored.

IHS project sites are often very large and would increase the cost of the achieving with this credit. The Sisseton "baseline" project site is approximately 25 acres requiring restoration of 12.5 acres. Consideration of smaller sites may be desirable, or possibly reducing the project site area after the Schematic Design Phase establishes the required site area.

Cost Estimates:

Restoration with native or adaptive vegetation will cost approximately $3,000 per acre, plus costs for temporary irrigation required to establish plants. In the case of the Sisseton "baseline" project, approximately 12.5 acres would require restoration at an approximate cost of $38,000.

Capital Cost: $0 - $38,000

Life Cycle Cost: None

Sustainable Sites Credit 5.2: Site Development, Maximize Open Space

Feasibility: High – IHS project sites are often large enough to meet this credit requirement.

Initial Cost Impact: None.

Mandate or Standard Practice	**$0 - $5K**	$5K - $50K	$50K - $150K	>$150K

Life-Cycle Cost Impact: None

Potential Savings	**$0 - $5K**	$5K - $50K	$50K - $150K	>$150K

Intent: Provide a high ratio of open space to development footprint to promote biodiversity.

Relevant Requirements:

Option 1: Reduce development footprint and/or provide vegetated open space within the project boundary to exceed the local zoning open space requirement by 25%

Option 2: For areas with no local zoning requirement, provide vegetated open space adjacent to building equal to the building footprint.

Option 3: Where zoning ordinance exists but has no open space requirement, provide vegetated open space equal to 20% of project site.

GSA Study Conclusions: No premium – GSA courthouses have significant setback requirements for security helping achieve open space requirements.

Other Considerations:

Additional credit is available under Innovation & Design if the required amount of open space has been doubled by the project.

If a large project site can be considered a "campus" for future development, open space may be separated from building.

Open space may include park and/or recreation space.

Cost Estimates:

Capital Cost: $0

Life Cycle Cost: $0

Sustainable Sites Credit 6.1: Stormwater Design, Quantity Control

Feasibility: Moderate – Sometimes achieved through standard practice. Additional design calculations required. May impact Site Selection process.

Initial Cost Impact: Moderate; potential capital investments include Stormwater detention basins, underground rainwater collection cisterns, exfiltration manholes, porous pavements, etc.

Mandate or Standard Practice	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Life-Cycle Cost Impact: Moderate; depending on technology – may require pump maintenance (e.g. underground rainwater detention basin,) filter maintenance and replacement, weed control (Stormwater basins,) fence repair, etc.

Potential Savings	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Intent: Limit disruption of natural hydrology by reducing impervious cover, increasing on-site infiltration, and managing stormwater runoff.

Relevant Requirements: Implement a stormwater management plan that prevents the post-development peak discharge rate and quantity from exceeding the pre-development peak discharge rate and quantity for one- and two-year, 24-hour design storms.

GSA Study Conclusions: High premium – Required the use of vegetated roofs to maintain post-development discharge rate and quantity.

Other Considerations: Sisseton "baseline" project complies with requirement. However, there is no AE guide requirement, nor is it know how many IHS projects comply through standard engineering practice.

Cost Estimates:

To establish a "maximum" cost scenario, assume a 5000 gallon underground rainwater detention tank (for reuse,) a stormwater detention basin (with fencing,) and necessary appurtenances.

Capital Cost: $0 to $75,000

Life Cycle Cost: $0 to $50,000

Sustainable Sites Credit 6.2: Stormwater Design, Quality Control

Feasibility: Low.

Initial Cost Impact: Moderate to high; depends on selection and approval of BMPs.

Mandate or Standard Practice	\$0 - \$5K	\$5K - \$50K	**\$50K - \$150K**	>\$150K

Life-Cycle Cost Impact: None to moderate; minimal maintenance required (above and beyond required maintenance for SS6.1.)

Potential Savings	**\$0 - \$5K**	**\$5K - \$50K**	\$50K - \$150K	>\$150K

Intent: Reduce or eliminate water pollution by reducing impervious cover, increasing onsite infiltration, eliminating sources of contaminants, and removing pollutants from stormwater runoff.

Relevant Requirements: Implement a stormwater management plan that reduces impervious cover, promotes infiltration and captures and treats stormwater runoff from 90% of the average rainfall using best management practices (BMPs) capable of removing 80% of the average annual post development total suspended solids (TSS) load.

GSA Study Conclusions: Moderate premium.

Other Considerations: None.

Cost Estimates:

For a “minimum” cost scenario, assume that nonstructural BMPs will meet the intent of this credit (e.g. drainage swales, porous pavements, vegetated filter strips, etc.) For a “maximum” cost scenario, assume adding a water quality basin in conjunction with a Stormwater quantity control basin.

Capital Cost: \$70,000 - \$180,000

Life Cycle Cost: \$0 - \$27,800

Sustainable Sites Credit 7.1: Heat Island Effect, Non-Roof

Feasibility: Low – difficult to achieve in large IHS parking lots.

Initial Cost Impact: Moderate to high; would require expensive paving materials (concrete paving with "white" concrete.

Mandate or Standard Practice	$0 - $5K	$5K - $50K	**$50K - $150K**	>$150K

Life-Cycle Cost Impact: None

Potential Savings	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Intent: Reduce heat islands to minimize impact on microclimate and human and wildlife habitat.

Relevant Requirements:

Option 1: Provide any combination of shade, paving materials with Solar Reflectance Index (SRI) of at least 29, or open grid pavement systems for 50% of site hardscape.

Option 2: Place 50% of parking spaces under cover. Roofs used to shade parking must have an SRI of 29.

GSA Study Conclusions: No premium – Parking is provided below grade.

Other Considerations:

IHS will only consider Option 1.

Additional credit is available under Innovation & Design if 100% of hardscape meets requirements.

Cost Estimates:

Factor the cost to use concrete paving in lieu of asphalt paving. Also add the cost for white concrete. For LCC implications, assume that asphalt paving would need to be replaced at 20 yrs whereas concrete paving would not. Net result = LCC savings.

Capital Cost: $120,000 - $143,300

Life Cycle Cost: ($11,800) – ($7,100)

Sustainable Sites Credit 7.2: Heat Island Effect, Roof

Feasibility: High.

Initial Cost Impact: Moderate; PVC roof costs more then EPDM.

Mandate or Standard Practice	$0 - $5K	**$5K - $50K**	$50K - $150K	>$150K

Life-Cycle Cost Impact: Reduced thermal loading will provide energy savings.

Potential Savings	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Intent: Reduce heat islands to minimize impact on microclimate and human and wildlife habitat.

Relevant Requirements:

Option 1: Use roofing materials with an SRI of 78 for low-sloped roofs and 29 for steep sloped roofs over 75% of roof surface.

Option 2: Install a vegetated roof for 50% of roof area.

Option 3: Install a combination of high albedo and vegetated roofs that meet SRI criteria in Option 1.

GSA Study Conclusions: No premium for use of white thermoplastic polyolefin (TPO) in lieu of black EPDM.

Other Considerations:

High albedo roofs may include higher initial and life cycle costs.

IHS will only consider Option 1.

Additional credit is available under Innovation & Design if SRI compliant materials are provided for 100% of roof's surface.

Cost Estimates:

Based on the Energy Star Roofing Calculator, a "cool roof" in the Sisseton area could save roughly $1500 per year in energy costs. PVC Roofs cost roughly $1.95 per SF compared to $1.63 per SF for EPDM.

Capital Cost: $22,500 - $27,500; Life Cycle Cost: ($9,200) – ($5,500)

Sustainable Sites Credit 8: Light Pollution Reduction

Feasibility: High.

Initial Cost Impact: Low to Moderate.

Mandate or Standard Practice	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Life-Cycle Cost Impact: None

Potential Savings	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Intent: Minimize light trespass from building and site, reduce sky-glow to increase night sky access, improve nighttime visibility, and reduce development impact on nocturnal environments.

Relevant Requirements:

Interior Lighting: Design lighting so that angle of maximum candela from luminaires does not exit through windows, or place non-emergency lighting on automatic controls that turn off after non-business hours. Manual overrides are allowable.

Exterior Lighting: Light only for safety and comfort. Do not exceed 80% of lighting power densities for exterior areas and 50% for building facades and landscape features as defined in ASHRAE 90.1-2004, Exterior Lighting Section. Classify projects into IESNA zones for Dark (Park and Rural), Low (Residential, Medium (Commercial/Industrial, High-Density Residential), and High (Major City Centers, Entertainment Districts).

GSA Study Conclusions: No premium.

Other Considerations: Some additional costs design costs may apply.

Cost Estimates:

Capital Cost: $0 - $10,000

Life Cycle Cost: None

Water Efficiency Credit 1.1: Water Efficient Landscaping, Reduce by 50%

Feasibility: Situational. May be more feasible in certain geographical locations in conjunction with WE Credit 1.2.

Initial Cost Impact: Moderate.

Mandate or Standard Practice	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Life-Cycle Cost Impact: None

Potential Savings	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Intent: Limit or eliminate the use of potable water, or other natural surface or subsurface water resources available on or near the project site, for landscape irrigation.

Relevant Requirements: Reduce potable water consumption for irrigation by 50% from a calculated mid-summer baseline case through any combination of the following:

1. Plant species factor
2. Irrigation efficiency
3. Use of captured rainwater
4. Use of recycled wastewater
5. Use of water treated and conveyed by public agency for non-potable uses

GSA Study Conclusions: No premium – achieved by limiting turfgrass to 15% of planting area, time and rain sensor controlled irrigation systems, and groundcovers with low water consumption needs.

Other Considerations: Some additional design costs may apply.

Cost Estimates:

To achieve sufficient efficiency to gain this credit, moisture sensors and enhanced controls would be required up front.

DRIP technology would require enhanced maintenance, and specialized maintenance; DRIP heads would need to be replaced more frequently, as they are more likely to clog. Water savings would reduce life cycle costs, but not enough to offset additional maintenance cost.

Capital Cost: $7,900 - $13,100

Life Cycle Cost: $9,200 - $21,000

Water Efficiency Credit 1.2: Water Efficient Landscaping, No Potable Water Use or No Irrigation

Feasibility: Situational. Xeriscaping may be more feasible in certain geographical locations eliminating the need for irrigation systems.

Initial Cost Impact: Low to Moderate (depending on design choice, Xeriscaping versus combination of rainwater harvesting and DRIP technology)

Mandate or Standard Practice	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Life-Cycle Cost Impact: Potential savings (water savings) to moderate (if rainwater harvesting/DRIP system is used.)

Potential Savings	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Intent: Eliminate the use of potable water, or other natural surface or subsurface water resources available on or near the project site, for landscape irrigation.

Relevant Requirements:

Option 1: Achieve WE Credit 1.1 and use only captured rainwater, recycled wastewater, recycled graywater, or water treated and conveyed by a public agency for non-potable use.

Option 2: Install landscaping that does not require permanent irrigation systems. Temporary irrigation is allowed to establish plants.

GSA Study Conclusions: No premium in certain areas – achieved by limiting turfgrass to 15% of planting area, time and rain sensor controlled irrigation systems, and groundcovers with low water consumption needs.

Other Considerations: Option 2 is considered to be most feasible approach. Captured rainwater systems add initial and life cycle cost. Recycled wastewater or graywater is undesirable, especially in healthcare projects. However, if public agency provided non-potable water is available, Option 1 might be reconsidered. Some additional design costs may apply.

Cost Estimates:

Minimum cost approach: assume Xeriscaping has same cost as standard turfgrass. Maximum cost approach: assume rainwater harvesting with DRIP technology.

Capital Cost: $0 - $55,500; Life Cycle Cost: ($22,900) - $48,200

Water Efficiency Credit 2: Innovative Wastewater Technologies

Feasibility: Low. Effectively requires the use of dry fixtures (composting toilets and waterless urinals) which may be undesirable in health care settings.

Initial Cost Impact: Moderate

Mandate or Standard Practice	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Life-Cycle Cost Impact: Moderate to High

Potential Savings	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Intent: Reduce generation of wastewater and potable water demand, while increasing the local aquifer recharge.

Relevant Requirements:

Option 1: Reduce potable water use for building sewage conveyance by 50% through use of water-conserving fixtures or non-potable water (captured rainwater, recycled graywater, and on-site or municipally treated wastewater).

Option 2: Treat 50% of wastewater on-site to tertiary standards. Treated water must be infiltrated or used on-site.

GSA Study Conclusions: Credit not pursued as it cannot be achieved through low-flow fixture types alone. Other methods of compliance are undesirable or cost prohibitive.

Other Considerations:

For the same reasons cited by the GSA Study, it is not recommended that IHS pursue this credit.

Additional credit is available under Innovation & Design for projects that demonstrate a 100% reduction potable water use for sewage conveyance.

Cost Estimates:

Combine cost of low-flow fixtures AND rainwater harvesting system. It would require regular O&M (annual cost) to maintain treatment system and pumps.

Capital Cost: $43,000 - $53,000

Life Cycle Cost: $58,000 - $71,000

Water Efficiency Credit 3.1 / Credit 3.2: Water Use Reduction 20% / 30%

Feasibility: Low. Effectively requires the use of dry fixtures (composting toilets and waterless urinals) which may be undesirable in health care settings.

Initial Cost Impact: Not Developed

Mandate or Standard Practice	\$0 - \$5K	\$5K - \$50K	\$50K - \$150K	>\$150K

Life-Cycle Cost Impact: Not Developed

Potential Savings	\$0 - \$5K	\$5K - \$50K	\$50K - \$150K	>\$150K

Intent: Maximize water efficiency within buildings to reduce the burden on municipal water supply and wastewater systems.

Relevant Requirements:

Option 1: Reduce potable water use for building sewage conveyance by 50% through use of water-conserving fixtures or non-potable water (captured rainwater, recycled graywater, and on-site or municipally treated wastewater).

Option 2: Treat 50% of wastewater on-site to tertiary standards. Treated water must be infiltrated or used on-site.

GSA Study Conclusions: No Premium for 20% reduction. Moderate premium for 30% Reduction. Achieved through use of water –conserving fixtures

Other Considerations:

Additional credit is available under Innovation & Design for a water use reduction of 40%.

Cost Estimates: None Developed.

Energy and Atmosphere Prerequisite 1: Fundamental Commissioning of the Building Energy Systems

Feasibility: High. AE guide currently mandates much of this requirement. Independent Commissioning Authority could add cost.

Initial Cost Impact: Moderate

Mandate or Standard Practice	$0 - $5K	**$5K - $50K**	$50K - $150K	>$150K

Life-Cycle Cost Impact: None

Potential Savings	**$0 - $5K**	$5K - $50K	$50K - $150K	>$150K

Intent: Verify that the building's energy related systems are installed, calibrated and perform according to the owner's project requirements, basis of design, and construction documents.

Relevant Requirements:

1. Designate Commissioning Authority (CA) to lead, review and oversee the completion of commissioning process activities
   a. CA shall have documented commissioning authority experience in 2 building projects.
   b. CA shall be independent of project's design and construction management, though they may be employee of firms providing those services. CA may be employee of Owner.
   c. CA shall report results, findings and recommendation directly to Owner.
   d. CA may be on design and construction team if project is smaller than 50,000 SF.
2. Owner shall provide project requirements, design team shall provide basis of design for review by CA.
3. Develop and incorporate commissioning requirements into the construction documents.
4. Develop and implement a commissioning plan.
5. Verify installation and performance of systems to be commissioned.
6. Complete a summary commissioning report.
7. Commissioning activities shall include HVAC&R systems and associated controls, lighting and daylighting controls, domestic hot water, and renewable energy systems.

GSA Study Conclusions: No Premium – GSA Standard.

Other Considerations: None.

Cost Estimates: Considered standard practice, however, *independent commissioning authority* could add significant cost.

Capital Cost: $0 - $50,000; Life Cycle Cost: None

Energy and Atmosphere Prerequisite 2: Minimum Energy Performance

Feasibility: Existing Mandate. AE Guide requires compliance with ASHRAE 90.1. Minor revisions may be necessary for complete compliance.

Initial Cost Impact: None

Mandate or Standard Practice	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Life-Cycle Cost Impact: None

Potential Savings	**$0 - $5K**	$5K - $50K	$50K - $150K	>$150K

Intent: Establish the minimum level of energy efficiency for the proposed building and systems.

Relevant Requirements: Design the building project to comply with:

1. Mandatory provisions of ASHRAE 90.1-2004.

2. Prescriptive requirements or performance requirements of ASHRAE 90.1-2004.

GSA Study Conclusions: No Premium – GSA Standard.

Other Considerations: None.

Cost Estimates: N/A

Energy and Atmosphere Prerequisite 3: Fundamental Refrigerant Management

Feasibility: Existing Mandate. AE guide currently mandates these basic requirements. Minor revisions may be necessary for compliance.

Initial Cost Impact: None

Mandate or Standard Practice	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Life-Cycle Cost Impact: None

Potential Savings	**$0 - $5K**	$5K - $50K	$50K - $150K	>$150K

Intent: Reduce Ozone depletion.

Relevant Requirements: Zero use of CFC-based refrigerants in new base building HVAC&R systems.

GSA Study Conclusions: No Premium – GSA Standard.

Other Considerations: None.

Cost Estimates: N/A

Energy and Atmosphere Credit 1: Optimize Energy Performance

Feasibility: High.

Initial Cost Impact: Highly variable, depending on how many points are sought (1-10).

Mandate or Standard Practice	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Life-Cycle Cost Impact: Considerable Savings.

Potential Savings	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Intent: Achieve increasing levels of energy performance above baseline standard in prerequisite to reduce environmental and economic impacts associated with excessive energy use.

Relevant Requirements:

Option 1: Whole Building Energy Simulation using the Building Performance Rating Method in ASHRAE 90.1-2004 Appendix G demonstrating improvement in building performance. Up to 10 points are available depending on the level of efficiency achieved starting at 10.5%

Option 2: Prescriptive Compliance Path – Four points for demonstrating compliance with ASHRAE Advanced Energy Design Guide for Small Office Buildings 2004 for office occupancies under 20,000 SF.

Option 3: Prescriptive Compliance Path – One point for demonstrating compliance with the Basic Criteria and Prescriptive Measures of the Advanced Buildings Benchmark Version 1.1.

GSA Study Conclusions: Highly variable cost premiums depending upon level of compliance.

Other Considerations:

IHS likely to pursue through Option 1 only.

Sisseton "baseline" project is able to achieve 7 points through increased building envelope performance and use of Ground Source Heat Pumps.

Energy Policy Act of 2005 may mandate 30% reduction. If so, 6 points will be earned on all projects.

Cost Estimates: See appendix

Energy and Atmosphere Credit 2: On-Site Renewable Energy

Feasibility: Moderate.

Initial Cost Impact: High.

Mandate or Standard Practice	$0 - $5K	$5K - $50K	$50K - $150K	**>$150K**

Life-Cycle Cost Impact: Moderate Savings.

Potential Savings	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Intent: Encourage and recognize increasing levels of on-site renewable energy self-supply in order to reduce environmental and economic impacts associated with fossil fuel energy use.

Relevant Requirements: Use on-site renewable energy systems to offset building energy costs. Up to 3 points achieved as follows:

2.5% offset: 1 point

7.5% offset: 2 points

12.5% offset: 3 points

Systems to consider include solar, wind, geothermal, low-impact-hydro, biomass, and bio-gas.

GSA Study Conclusions: High premium – Rooftop photovoltaic system considered.

Other Considerations:

Most practical approach will be to install a rooftop photovoltaic system. Due to high initial cost, the return on investment is very long term – 50+ years, while the system itself has only an estimated 20-year lifespan. Therefore, the decision to pursue this credit will not be based upon cost savings, but upon energy savings to lessen environmental impact.

Cost Estimates:

Capital Cost: $250,000 - $300,000.

Life Cycle Cost: ($43,900) – ($32,400)

Energy and Atmosphere Credit 3: Enhanced Commissioning

Feasibility: Moderate.

Initial Cost Impact: Moderate.

Mandate or Standard Practice	$0 - $5K	**$5K - $50K**	$50K - $150K	>$150K

Life-Cycle Cost Impact: None.

Potential Savings	**$0 - $5K**	$5K - $50K	$50K - $150K	>$150K

Intent: Begin the commissioning process early during the design process and execute additional activities after systems performance verification is completed.

Relevant Requirements:

1. Designate Commissioning Authority (CA) to lead, review and oversee the completion of commissioning process activities
   a. CA shall have documented commissioning authority experience in 2 building projects.
   b. CA shall be independent of the design and construction work, not employed by designer (may be subcontracted), and not employed by or contracted through contractor. CA may be Owner employee.
   c. CA shall report findings and recommendations directly to Owner.
2. CA shall conduct minimum of 1 commissioning design review of Project Requirements, Basis of Design, and Design Documents prior to mid-construction documents phase followed by a backcheck of review in subsequent submission.
3. CA shall review contractor submittals for compliance with Project Requirements and Basis of Design.
4. Develop systems manual providing for optimal operation of commissioned systems.
5. Complete training requirements for operating personnel.
6. CA shall review building operation within 10 months of substantial completion with O&M staff. Develop plan of resolution of outstanding issues.

GSA Study Conclusions: No premium – GSA Standard.

Other Considerations: None.

Cost Estimates:

Capital Cost: $10,000 - $30,000

Life Cycle Cost: None

Energy and Atmosphere Credit 4: Enhanced Refrigerant Management

Feasibility: Moderate.

Initial Cost Impact: Needs further study.

Mandate or Standard Practice	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Life-Cycle Cost Impact: None.

Potential Savings	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Intent: Reduce ozone depletion and support early compliance with Montreal Protocol while minimizing direct contributions to global warming.

Relevant Requirements:

Option 1: Do not use refrigerants.

Option 2: Select refrigerants and HVAC&R that minimize or eliminate the emission of compounds that contribute to ozone depletion and global warming

GSA Study Conclusions: Not applicable – GSA buildings do not include building refrigeration systems.

Other Considerations: Allows use of less harmful HCFCs.

Cost Estimates:

Capital Cost: $0 - $20,000

Life Cycle Cost: $5,600 - $75,00

Energy and Atmosphere Credit 5: Measurement & Verification

Feasibility: High. Standard DDC components meet much of this requirement.

Initial Cost Impact: Low.

Mandate or Standard Practice	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Life-Cycle Cost Impact: Low to Moderate.

Potential Savings	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Intent: Provide for the ongoing accountability and organization of building energy consumption performance over time.

Relevant Requirements:

Develop and implement a Measurement & Verification (M&V) Plan consistent with Option D: Calibrated Simulation, or Option B: Energy Conservation Measure Isolation as specified in the IPMVP.

The M&V period shall cover no less than one year of post-construction occupancy.

GSA Study Conclusions: Moderate Premium.

Other Considerations: None.

Cost Estimates:

Capital Cost: $3,000 - $12,000

Life Cycle Cost: $3,700 - $1,500

Energy and Atmosphere Credit 6: Green Power

Feasibility: Non-Construction. Requires energy purchase contract.

Initial Cost Impact: NA.

Mandate or Standard Practice	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Life-Cycle Cost Impact: Increased – Presumed purchase of energy from renewable sources at higher rates than standard sources. This may change over time as renewable sources become more available. Cost estimate needs development.

Potential Savings	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Intent: Encourage the development and use of grid-source, renewable energy technologies on a net zero pollution basis.

Relevant Requirements:

Provide at least 35% of building's electricity from renewable sources by engaging in a two-year renewable energy contract.

To determine the baseline electricity use, use the annual electricity consumption from the results of EA Credit 1 or use the DOE Commercial Buildings Energy Consumption Survey database to determine estimated electricity use.

Renewable energy certificates and tradable renewable certificates may be used to comply with requirement.

GSA Study Conclusions: Beyond scope of study.

Other Considerations: None.

Cost Estimates: Needs Development.

Materials and Resources Prerequisite 1: Storage & Collection of Recyclables

Feasibility: High. Requires programmatic change to include additional space (approximately 225-275 SF) for storage and collection of recyclables.

Initial Cost Impact: Low to Moderate.

Mandate or Standard Practice	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Life-Cycle Cost Impact: Moderate to High.

Potential Savings	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Intent: Facilitate the reduction of waste generated by building occupants that is disposed of in landfills.

Relevant Requirements: Provide an easily accessible area dedicated to the separation, collection and storage of recyclables (paper, corrugated cardboard, glass, plastics and metals).

GSA Study Conclusions: No premium – GSA Standard.

Other Considerations: None.

Cost Estimates:

Capital Cost: $25,000 - $55,000

Life Cycle Cost: $5,700 - $70,500

Materials and Resources Credit 1.1: Building Reuse, Maintain 75% of Existing Walls, Floors, & Roof

Feasibility: Situational. Only applies to major renovation projects

Initial Cost Impact: Highly Variable; not developed in this analysis.

Mandate or Standard Practice	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Life-Cycle Cost Impact: None.

Potential Savings	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Intent: Extend the life cycle of existing building stock, conserve resources, retain cultural resources, reduce waste and reduce environmental impacts of new buildings as they relate to materials manufacturing and transport.

Relevant Requirements: Maintain at least 75% of existing building structure and envelope. Remediated hazardous materials are excluded from the calculation. For projects with additions, this credit is not applicable if the addition is more than 2x the square footage of the existing building.

GSA Study Conclusions: No premium where feasible.

Other Considerations: None.

Cost Estimates:

Capital Cost: Not Developed.

Life Cycle Costs: None

Materials and Resources Credit 1.2: Building Reuse, Maintain 95% of Existing Walls, Floors, & Roof

Feasibility: Situational. Only applies to major renovation projects

Initial Cost Impact: Highly Variable; not developed in this analysis.

Mandate or Standard Practice	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Life-Cycle Cost Impact: None.

Potential Savings	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Intent: Extend the life cycle of existing building stock, conserve resources, retain cultural resources, reduce waste and reduce environmental impacts of new buildings as they relate to materials manufacturing and transport.

Relevant Requirements: Maintain an additional 20% of existing building structure and envelope. Remediated hazardous materials are excluded from the calculation. For projects with additions, this credit is not applicable if the addition is more than 2x the square footage of the existing building.

GSA Study Conclusions: No premium where feasible.

Other Considerations: None.

Cost Estimates:

Capital Cost: Not Developed.

Life Cycle Costs: None

Materials and Resources Credit 1.3: Building Reuse, Maintain 50% of Interior Non-Structural Elements

Feasibility: Situational. Only applies to major renovation projects

Initial Cost Impact: Highly Variable; not developed in this analysis.

Mandate or Standard Practice	$0 - 5K	$5K - $50K	$50K - $150K	>$150K

Life-Cycle Cost Impact: None.

Potential Savings	**$0 - $5K**	$5K - $50K	$50K - $150K	>$150K

Intent: Extend the life cycle of existing building stock, conserve resources, retain cultural resources, reduce waste and reduce environmental impacts of new buildings as they relate to materials manufacturing and transport.

Relevant Requirements: Use existing non-structural elements in at least 50% of the completed building. For projects with additions, this credit is not applicable if the addition is more than 2x the square footage of the existing building.

GSA Study Conclusions: No premium where feasible.

Other Considerations: None.

Cost Estimates:

Capital Cost: Not Developed.

Life Cycle Costs: None

Materials and Resources Credit 2.1 / 2.2: Building Reuse, Construction Waste Management, Divert 50% / 75% from Disposal

Feasibility: Situational. May be impractical in remote locations where recycle facilities may not be readily available.

Initial Cost Impact: Highly variable; not developed in this analysis.

Mandate or Standard Practice	\$0 - \$5K	\$5K - \$50K	\$50K - \$150K	>\$150K

Life-Cycle Cost Impact: None.

Potential Savings	**\$0 - \$5K**	\$5K - \$50K	\$50K - \$150K	>\$150K

Intent: Divert construction, demolition and land clearing debris from landfill and incinerator disposal. Redirect recyclable recovered resources back to the manufacturing process. Redirect reusable materials to appropriate sites.

Relevant Requirements: Develop and implement a waste management plan to recycle and/or salvage 50% or 75% (by weight or volume) waste and debris from landfills.

GSA Study Conclusions: Moderate premium.

Other Considerations:

Additional credit is available under Innovation & Design when the percent of total diverted waste is 95% or greater.

Cost Estimates:

Capital Cost: Not Developed.

Life Cycle Cost: None

Materials and Resources Credit 3.1 / 3.2: Materials Reuse, 5% / 10%

Feasibility: Low. Types of materials that qualify and are available typically are not used in large enough quantities and may be undesirable in health care environments.

Initial Cost Impact: Highly variable; not developed in this analysis.

Mandate or Standard Practice	$0 - 5K	$5K - $50K	$50K - $150K	>$150K

Life-Cycle Cost Impact: None.

Potential Savings	**$0 - $5K**	$5K - $50K	$50K - $150K	>$150K

Intent: Reuse building materials and products in order to reduce demand for virgin materials.

Relevant Requirements: Use salvaged, refurbished, or reused materials, products and furnishings for at least 5% or 10% (material cost) of permanently installed building materials. Mechanical, electrical, plumbing and specialty items are not eligible.

GSA Study Conclusions: Not pursued by study.

Other Considerations:

Additional credit is available under Innovation & Design when the value of salvaged or reused materials is 15% or greater.

Cost Estimates:

Capital Cost: None

Life Cycle Costs: None

Materials and Resources Credit 4.1 / 4.2: Recycled Content, 10% / 20% (post-consumer + ½ pre-consumer)

Feasibility: Moderate for 10% / Low for 20%. Types of materials that qualify and are available typically are not used in large enough quantities.

Initial Cost Impact: Highly Variable.

Mandate or Standard Practice	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Life-Cycle Cost Impact: None.

Potential Savings	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Intent: Increase demand for building products incorporating recycled content.

Relevant Requirements: Use materials such that the sum of post-consumer + ½ post-industrial content constitutes 10% or 20% (material cost) of building materials.

GSA Study Conclusions: Under version 2.1, the targeted goals were 5% and 10%. The study indicates no premium to achieve 10% due to the high volume of recycled metal available in steel stud construction and other factors.

Other Considerations:

Additional credit is available under Innovation & Design when the recycled content is 30% or greater.

Cost Estimates:

Capital Cost: $0 - $50,000 (MR4.1; not developed for MR4.2)

Life Cycle Costs: None (both MR4.1 and MR4.2)

Materials and Resources Credit 5.1 / 5.2: Regional Materials, 10% / 20% extracted. Processed & Manufactured Regionally

Feasibility: Situational.

Initial Cost Impact: Highly Variable.

Mandate or Standard Practice	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Life-Cycle Cost Impact: None.

Potential Savings	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Intent: Increase demand for building materials and products that are extracted and manufactured regionally supporting use of indigenous resources and reducing transportation impacts.

Relevant Requirements: Use materials extracted, harvested, and manufactured within 500 miles of project site for 10% or 20% of total materials cost. Mechanical, electrical, plumbing and specialty items are not eligible.

GSA Study Conclusions: Under version 2.1, the targeted goals were 5% and 10%. The study indicates no premium to achieve 10% due to the high volume of recycled metal available in steel stud construction and other factors.

Other Considerations:

Additional credit is available under Innovation & Design when the content of regionally harvested, extracted, and manufactured materials is 40% or greater.

Cost Estimates:

Capital Cost: $0 - $50,000 (MR4.1; not developed for MR4.2)

Life Cycle Costs: None (both MR4.1 and MR4.2)

Materials and Resources Credit 6: Rapidly Renewable Materials

Feasibility: Low.

Initial Cost Impact: Highly variable; not developed in this analysis.

Mandate or Standard Practice	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Life-Cycle Cost Impact: Not developed in this analysis.

Potential Savings	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Intent: Reduce the use and depletion of finite raw materials and long-cycle renewable materials by replacing them with rapidly renewable materials.

Relevant Requirements: Use rapidly renewable materials and products (10-year harvest cycle) for 2.5% of total value of building materials.

GSA Study Conclusions: Under version 2.1 the targeted goal was 5%. GSA concluded that threshold would be too difficult to pursue due to the limited types of compliant materials available.

Other Considerations:

Compliant materials include bamboo flooring, cotton batt insulation, linoleum flooring, sunflower seed bead panels, wheatboard cabinetry, wool carpeting, and cork flooring

Additional credit is available under Innovation & Design when the rapidly renewable material content is 10% or greater.

Cost Estimates:

None Developed.

Materials and Resources Credit 7: Certified Wood

Feasibility: Low.

Initial Cost Impact: Highly variable; none developed in this analysis.

Mandate or Standard Practice	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Life-Cycle Cost Impact: None or Insignificant.

Potential Savings	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Intent: Encourage environmentally responsible forest management.

Relevant Requirements: Use 50% of wood-based materials certified by the Forest Stewardship Council (FST).

GSA Study Conclusions: High Premium due to the cost of FSC Certified wood.

Other Considerations:

Very few wood based materials are used in IHS projects, therefore paying a premium for such materials may have an insignificant impact upon the total cost of the project.

Additional credit is available under Innovation & Design when the FSC certified wood content is 95% or greater.

Cost Estimates:

None Developed.

Indoor Environmental Quality Prerequisite 1: Minimum IAQ Performance

Feasibility: Existing Mandate. Compliance with AIA Guidelines appears to meet intent. CIR may be required for confirmation from USGBC.

Initial Cost Impact: Existing Mandate.

Mandate or Standard Practice	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Life-Cycle Cost Impact: Existing Mandate.

Potential Savings	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Intent: Establish minimum IAQ performance to enhance indoor air quality contributing to comfort and well-being of occupants.

Relevant Requirements: Meet the minimum requirements of the ASHRAE 62.1-2004 using the Ventilation Rate Procedure.

GSA Study Conclusions: No Premium – GSA Standard.

Other Considerations: None.

Cost Estimates:

Capital Cost: None

Life Cycle Cost: None

Indoor Environmental Quality Prerequisite 2: Environmental Tobacco Smoke (ETS) Control

Feasibility: Existing Mandate.

Initial Cost Impact: Existing Mandate.

Mandate or Standard Practice	$0 - 5K	$5K - $50K	$50K - $150K	>$150K

Life-Cycle Cost Impact: Existing Mandate.

Potential Savings	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Intent: Prevent exposure of building occupants, indoor surfaces, and ventilation air distribution and systems to ETS.

Relevant Requirements: Prohibit smoking in building and near entries and operable windows. Locate any exterior designated smoking areas at least 25 feet away from entries, outdoor air intakes and operable windows.

GSA Study Conclusions: No Premium – GSA Standard.

Other Considerations: None.

Cost Estimates:

Capital Cost: None.

Life Cycle Cost: None.

Indoor Environmental Quality Credit 1: Outdoor Air Delivery Monitoring

Feasibility: High. Simple to comply with typical DDC system. Some additional metering may be required.

Initial Cost Impact: Low.

Mandate or Standard Practice	**$0 - 5K**	$5K - $50K	$50K - $150K	>$150K

Life-Cycle Cost Impact: Low.

Potential Savings	**$0 - $5K**	$5K - $50K	$50K - $150K	>$150K

Intent: Provide capacity for IAQ monitoring to help sustain long-term occupant comfort and well-being.

Relevant Requirements: Install a permanent CO2 monitoring system that affords operational adjustment. Monitor all spaces with occupant density greater than 25 people per 1,000 SF.

GSA Study Conclusions: Moderate Premium to provide additional metering.

Other Considerations: None.

Cost Estimates:

Capital Cost: $0 - $2,600

Life Cycle Cost: $700 - $1,200

Indoor Environmental Quality Credit 2: Increased Ventilation

Feasibility: High.

Initial Cost Impact: Low.

Mandate or Standard Practice	**$0 - $5K**	$5K - $50K	$50K - $150K	>$150K

Life-Cycle Cost Impact: Moderate.

Potential Savings	$0 - $5K	**$5K - $50K**	$50K - $150K	>$150K

Intent: Provide additional outdoor air ventilation to improve indoor air quality for improved comfort, well-being and productivity.

Relevant Requirements: Increase breathing zone outdoor air ventilation rates to all occupied spaces by 30% above ASHRAE 62.1 rates.

GSA Study Conclusions: Low Premium to document performance.

Other Considerations: None.

Cost Estimates:

Capital Cost: $0 - $5,000

Life Cycle Cost: $14,300 - $47,700

Indoor Environmental Quality Credit 3.1: Construction IAQ Management Plan, During Construction

Feasibility: High.

Initial Cost Impact: Low.

Mandate or Standard Practice	**$0 - $5K**	$5K - $50K	$50K - $150K	>$150K

Life-Cycle Cost Impact: None.

Potential Savings	**$0 - $5K**	$5K - $50K	$50K - $150K	>$150K

Intent: Prevent IAQ problems resulting from construction process.

Relevant Requirements:

1. Meet SMACNA IAQ Control Measures for Buildings under Construction.
2. Protect stored or installed absorptive materials from water damage.
3. Protect air handlers used during construction with MERV 8 filters.

GSA Study Conclusions: Low Premium to cover additional contractor requirements.

Other Considerations: Additional costs incurred due to additional contractor requirements.

Cost Estimates:

Capital Cost: $900 - $3,500

Life Cycle Cost: None

Indoor Environmental Quality Credit 3.2: Construction IAQ Management Plan, Before Occupancy

Feasibility: High. Requires a willingness on part of owner to allow completed building to remain unoccupied. Some occupancy is allowed after 3,500 CF per SF has been reached.

Initial Cost Impact: Low.

Mandate or Standard Practice	**$0 - $5K**	$5K - $50K	$50K - $150K	>$150K

Life-Cycle Cost Impact: None.

Potential Savings	**$0 - $5K**	$5K - $50K	$50K - $150K	>$150K

Intent: Prevent IAQ problems resulting from construction process.

Relevant Requirements:

Option 1 – Flush-Out: After construction and prior to occupancy, conduct a building flush-out by supplying 14,000 CF per SF of outside air while maintaining internal temperature of 60^{o}F and ≤60% RH. Some occupancy is allowed after 3,500 CF per SF has been reached.

Option 2 – Air Quality Testing: Conduct baseline testing after construction ends and prior to occupancy demonstrating that contaminant concentration doesn't exceed LEED proscribed maximums.

GSA Study Conclusions: Low Premium to cover additional contractor requirements.

Other Considerations: None

Cost Estimates:

Capital Cost: $600 to $3,600.

Life Cycle Cost: None

Indoor Environmental Quality Credit 4.1: Low-Emitting Materials, Adhesives & Sealants

Feasibility: High.

Initial Cost Impact: Moderate.

Mandate or Standard Practice	**$0 - $5K**	$5K - $50K	$50K - $150K	>$150K

Life-Cycle Cost Impact: None or Insignificant.

Potential Savings	**$0 - $5K**	$5K - $50K	$50K - $150K	>$150K

Intent: Reduce quantity of potentially harmful indoor air contaminants.

Relevant Requirements: Specify interior adhesives and sealants with VOC contents meeting South Coast Air Quality Management District Rule #1168 and Bay Area Air Quality Management District Regulation 8, Rule 51.

GSA Study Conclusions: No premium – Many compliant products available.

Other Considerations: Anecdotal information available that low VOC products do not perform well.

Cost Estimates:

Capital Cost: $0 - $1,600

Life Cycle Cost: None

Indoor Environmental Quality Credit 4.2: Low-Emitting Materials, Paints & Coatings

Feasibility: High.

Initial Cost Impact: Moderate.

Mandate or Standard Practice	**$0 - 5K**	**$5K - $50K**	$50K - $150K	>$150K

Life-Cycle Cost Impact: None or Insignificant.

Potential Savings	**$0 - $5K**	$5K - $50K	$50K - $150K	>$150K

Intent: Reduce quantity of potentially harmful indoor air contaminants.

Relevant Requirements: Specify paints, coatings and primers with VOC limits compliant with Green Seal's Standard GS-11. Specify anti-corrosive paints with VOC limits compliant with Green Seal Standard GC-03. Specify clear finishes, coatings and sealers with VOC limits compliant with SCAQMD Rule 1113.

GSA Study Conclusions: No premium – Many compliant products available.

Other Considerations: Anecdotal information available that low VOC products do not perform well.

Cost Estimates:

Capital Cost: $0 - $21,000

Life Cycle Cost: None

Indoor Environmental Quality Credit 4.3: Low-Emitting Materials, Carpet Systems

Feasibility: High.

Initial Cost Impact: None to Moderate.

Mandate or Standard Practice	$0 - 5K	$5K - $50K	$50K - $150K	>$150K

Life-Cycle Cost Impact: None or Insignificant.

Potential Savings	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Intent: Reduce quantity of potentially harmful indoor air contaminants.

Relevant Requirements: Carpet systems must meet the requirements of the Carpet and Rug Institute's Green Label Plus Program.

GSA Study Conclusions: No premium – GSA Standard.

Other Considerations: Most major carpet manufacturers comply with the CRI Standard.

Cost Estimates:

Capital Cost: $0 - $14,000

Life Cycle Cost: None

Indoor Environmental Quality Credit 4.4: Low-Emitting Materials, Composite Wood & Agrifiber Products

Feasibility: High.

Initial Cost Impact: None to Moderate.

Mandate or Standard Practice	$0 - 5K	$5K - $50K	$50K - $150K	>$150K

Life-Cycle Cost Impact: None or Insignificant.

Potential Savings	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Intent: Reduce quantity of potentially harmful indoor air contaminants.

Relevant Requirements: Composite wood and agrifiber products must contain no added urea-formaldehyde resins. Typical applications include millwork substrates, wood doors, and miscellaneous blocking.

GSA Study Conclusions: High premium due to high cost of materials.

Other Considerations: None.

Cost Estimates:

Capital Cost: $0 - $31,000

Life Cycle Cost: None

Indoor Environmental Quality Credit 5: Indoor Chemical & Pollutant Source Control

Feasibility: High. Potential cost impact due to room separations and additional filtering.

Initial Cost Impact: Moderate.

Mandate or Standard Practice	$0 - 5K	$5K - $50K	$50K - $150K	>$150K

Life-Cycle Cost Impact: Low.

Potential Savings	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Intent: Avoid exposure of building occupants to potentially hazardous chemicals.

Relevant Requirements:

1. Provide entryway systems to capture dirt (grilles, grates, or mats).
2. Segregate areas where chemicals are used with deck to deck partitions (or hard lid ceilings) and separate exhausts.
3. Provide drains for disposal of liquid waste where water and chemical mixing occurs.
4. Provide MERV 13 filters serving regularly occupied areas.

GSA Study Conclusions: No Premium – GSA Standard.

Other Considerations: None.

Cost Estimates:

Capital Cost: $1,300 - $25,000

Life Cycle Cost: $1,200 - $2,500 (High Efficiency Filter Replacement)

Indoor Environmental Quality Credit 6.1: Controllability of Systems, Lighting

Feasibility: High.

Initial Cost Impact: Low to Moderate.

Mandate or Standard Practice	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Life-Cycle Cost Impact: None or Insignificant.

Potential Savings	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Intent: Provide a high level of lighting system control by individual occupants to promote the productivity, comfort and well-being of occupants.

Relevant Requirements: Provide individual lighting controls for 90% of occupants to enable adjustments to suit individual tasks.

GSA Study Conclusions: NA – Significant change between version 2.1 and 2.2.

Other Considerations: None.

Cost Estimates:

Capital Cost: $0 - $5,000

Life Cycle Cost: None

Indoor Environmental Quality Credit 6.2: Controllability of Systems, Thermal Comfort

Feasibility: Moderate. Complicates design and performance of HVAC system. Requires additional HVAC components such as VAV boxes.

Initial Cost Impact: None developed in this analysis.

Mandate or Standard Practice	\$0 - \$5K	\$5K - \$50K	\$50K - \$150K	>\$150K

Life-Cycle Cost Impact: None developed in this analysis.

Potential Savings	\$0 - \$5K	\$5K - \$50K	\$50K - \$150K	>\$150K

Intent: Provide a high level of thermal comfort system control by individual occupants to promote the productivity, comfort and well-being of occupants.

Relevant Requirements: Provide individual comfort controls for 50% of occupants to enable adjustments to suit individual preferences. Operable windows may meet requirements for areas within 20 feet of exterior wall.

GSA Study Conclusions: NA – Significant change between version 2.1 and 2.2.

Other Considerations: None.

Cost Estimates: None developed in this analysis.

Indoor Environmental Quality Credit 7.1: Thermal Comfort, Design

Feasibility: Existing Mandate. AIA Guidelines currently mandate these basic requirements.

Initial Cost Impact: None.

Mandate or Standard Practice	$0 - 5K	$5K - $50K	$50K - $150K	>$150K

Life-Cycle Cost Impact: None.

Potential Savings	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Intent: Provide a comfortable thermal environment that supports productivity and well-being of occupants.

Relevant Requirements: Comply with ASHRAE 55-2004 requirements for humidity control.

GSA Study Conclusions: No Premium – GSA Standard.

Other Considerations: None.

Cost Estimates:

No cost: mandate or standard practice.

Indoor Environmental Quality Credit 7.2: Thermal Comfort, Verification

Feasibility: High.

Initial Cost Impact: Low.

Mandate or Standard Practice	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Life-Cycle Cost Impact: None.

Potential Savings	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Intent: Provide for the assessment of building thermal comfort over time.

Relevant Requirements: Implement a thermal comfort survey of occupants 6-18 months after occupancy assessing overall satisfaction and identification of problems. Develop a plan for corrective action if more than 20% of occupants are dissatisfied with thermal comfort.

GSA Study Conclusions: NA – Significant change between version 2.1 and 2.2.

Other Considerations: None.

Cost Estimates:

Capital Cost: $0 - $5,000

Life Cycle Cost: none

Indoor Environmental Quality Credit 8.1: Daylight and Views, Daylight 75% of Spaces

Feasibility: Low. May be difficult to achieve in large footprints and undesirable in certain departments.

Initial Cost Impact: None developed in this analysis.

Mandate or Standard Practice	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Life-Cycle Cost Impact: None developed in this analysis.

Potential Savings	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Intent: Provide a connection between indoor spaces and outdoors through the introduction of daylight and views.

Relevant Requirements: Achieve a Daylight Factor of 2% in 75% of occupied spaces. Daylight Factor calculation considers window area, geometry, and height factors. Alternatively, demonstrate through computer simulation that 25% footcandles of daylight illumination is achieved.

GSA Study Conclusions: Credit not pursued as too difficult to accommodate building function.

Other Considerations:

Additional credit is available under Innovation & Design when the project achieves 95% daylighting.

Complicates design process.

Cost Estimates:

None developed in this analysis.

Indoor Environmental Quality Credit 8.2: Daylight and Views, Views for 90% of Spaces

Feasibility: Low. May be difficult to achieve in large footprints and undesirable in certain departments. Complicates design process.

Initial Cost Impact: None developed in this analysis.

Mandate or Standard Practice	$0 - $5K	$5K - $50K	$50K - $150K	>$150K

Life-Cycle Cost Impact: None.

Potential Savings	**$0 - $5K**	$5K - $50K	$50K - $150K	>$150K

Intent: Provide a connection between indoor spaces and outdoors through the introduction of daylight and views.

Relevant Requirements: Achieve direct line of sight to vision glazing for 90% of regularly occupied spaces.

GSA Study Conclusions: Credit not pursued as too difficult to accommodate building function.

Other Considerations:

Additional credit is available under Innovation & Design on a case by case basis.

Complicates design process.

Cost Estimates:

None developed in this analysis; LCC assumed to be zero.

Innovation & Design Process Credit Potential:

Possible Credit: SS5.1 Site Development, Protect or Restore Habitat

Relevant Requirements: On previously developed sites, restore 75% of the site area. (Baseline restoration is 50%).

Cost Estimates: $18,000 - $21,000

Possible Credit: SS5.2 Site Development, Maximize Open Space

Relevant Requirements: Provide vegetated open space equal to twice the building footprint. (Baseline open space requirement is equal to building footprint).

Cost Estimates: Nothing, where project site size accommodates requirement.

Possible Credit: SS7.1 Heat Island Effect, Non-Roof

Relevant Requirements: Provide shade, SRI 29 paving, or open grid pavement for 100% of hardscape. (Baseline is 50% of hardscape).

Cost Estimates:

Capital Cost: $240,000 - $286,600 (double the cost of SS7.1)
Life Cycle Cost: $7,100-$11,800 **Savings** (equal the savings of SS7.1)

Possible Credit: SS7.2 Heat Island Effect, Roof

Relevant Requirements: Provide shade, SRI 78 roofing over 100% of roof surface. (Baseline is 75% of roof surface).

Cost Estimates: Nothing, where project site size accommodates requirement.

Possible Credit: SS7.2 Heat Island Effect, Roof

Relevant Requirements: Provide shade, SRI 78 roofing over 100% of roof surface. (Baseline is 75% of roof surface).

Cost Estimates: Nothing, where project site size accommodates requirement.

Innovation and Design Process Credit 2: LEED Accredited Professional

Feasibility: High

Initial Cost Impact: None.

Mandate or Standard Practice	$0 - 5K	$5K - $50K	$50K - $150K	>$150K

Life-Cycle Cost Impact: None.

Potential Savings	**$0 - $5K**	$5K - $50K	$50K - $150K	>$150K

Intent: To support and encourage the design integration required by a LEED-NC green building project and to streamline the application and certification process.

Relevant Requirements: At least on principal participant of the project team shall be a LEED Accredited Professional.

GSA Study Conclusions: No Premium.

Other Considerations: Many LEED Accredited Professionals available within IHS for every project. Also, LAPs are commonly available within many AE firms.

Cost Estimates:

No cost – DES Staff includes accredited professionals.

Section 4:
Summary of Findings

Introduction

The scope of this paper was to provide a framework for planning IHS facilities to achieve sustainable design principles through pursuit of a LEED certification. The information included a summary of the credits available under the LEED-NC version 2.2 template, and outlined the scoring system for achieving sufficient credits to earn either a basic or a silver certification. In order to evaluate the potential cost impacts from implementing these standards, the Sisseton Ambulatory Care Facility was evaluated under its current design, and each credit was analyzed in terms of feasibility and cost premiums (capital and life cycle costs.) Due to a few unique factors inherent in this facility (i.e. ground source heat pump, enhanced Stormwater management, etc,) these were identified and evaluated so as to not skew the cost impacts in the government's favor.

These cost premiums were enumerated in Table 2.2. In addition to listing these factors, each credit was categorized in a hierarchical structure, so as to identify which credits were most advantageous to pursue; not only in terms of cost, but also in terms of feasibility. The *Situational Feasibility* category in this table includes credits, which may fit well in other new IHS facilities, but are not considered highly feasible in the Sisseton case. Table 2.3 combined capital cost premiums with 20-yr life cycle cost premiums to develop a range of *aggregate life cycle costs*. This identified four credits, which are disproportionately costly, and may not be effective to pursue without first examining situational credits (tier 6.)

Full detail of each credit was provided in Section 3, wherein individual summary sheets were included. Each contains an abstract of the intent for each credit, observations made for the same credit in the GSA study, cost estimate data, and other considerations (where applicable.)

Using the LEED Checklist to Develop a Cost Estimate

The information contained in Table 2.2 is used to select the most desirable credits in the following checklist (Table 4-4.) This checklist is the official form used in the LEED application process. Additional columns have been included to contain cost data as represented in Table 2.2. Because silver certification may be feasible in some cases, additional columns have been added to account for the credits most likely to be chosen under this scenario.

LEED-NC

LEED-NC Version 2.2 Registered Project Checklist

IHS Evaluation Project - Sisseton

C	S			Points Possible	Points Earned C	Points Earned S	Capital Cost Impacts: Basic Certification Low	Basic Certification High	Silver Certification Low	Silver Certification High
0	0		**Sustainable Sites**	14 Points	5	6	$22,500	$125,200	$142,500	$268,600
✓	✓	Prereq 1	**Construction Activity Pollution Prevention**	Required			$0	$0	$0	$0
		Credit 1	**Site Selection**	1						
		Credit 2	**Development Density & Community Connectivity**	1						
		Credit 3	**Brownfield Redevelopment**	1						
		Credit 4.1	**Alternative Transportation**, Public Transportation Access	1						
✓	✓	Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	1	1	1	$0	$1,200	$0	$1,200
		Credit 4.3	**Alternative Transportation**, Low-Emitting and Fuel-Efficient Vehicles	1						
✓	✓	Credit 4.4	**Alternative Transportation**, Parking Capacity	1	1	1	$0	$0	$0	$0
		Credit 5.1	**Site Development,** Protect of Restore Habitat	1						
		Credit 5.2	**Site Development,** Maximize Open Space	1						
✓	✓	Credit 6.1	**Stormwater Design,** Quantity Control	1	1	1	$0	$83,500	$0	$83,500
		Credit 6.2	**Stormwater Design,** Quality Control	1						
	✓	Credit 7.1	**Heat Island Effect,** Non-Roof	1		1			$120,000	$143,400
✓	✓	Credit 7.2	**Heat Island Effect,** Roof	1	1	1	$22,500	$27,500	$22,500	$27,500
✓	✓	Credit 8	**Light Pollution Reduction**	1	1	1	$0	$13,000	$0	$13,000
C	S									
0	0		**Water Efficiency**	5 Points	2	2	$7,900	$58,100	$7,900	$58,100
✓	✓	Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%	1	1	1	$7,900	$13,100	$7,900	$13,100
✓	✓	Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	1	1	1	$0	$45,000	$0	$45,000
		Credit 2	**Innovative Wastewater Technologies**	1						
		Credit 3.1	**Water Use Reduction**, 20% Reduction	1						
		Credit 3.2	**Water Use Reduction**, 30% Reduction	1						
Yes	C									
0	0		**Energy & Atmosphere**	17 Points	9	12	$87,700	$152,500	$386,700	$531,900
✓	✓	Prereq 1	**Fundamental Commissioning of the Building Energy Systems**	Required			$18,000	$22,000	$18,000	$22,000
✓	✓	Prereq 2	**Minimum Energy Performance**	Required			$0	$0	$0	$0
✓	✓	Prereq 3	**Fundamental Refrigerant Management**	Required			$0	$0	$0	$0
✓	✓	Credit 1	**Optimize Energy Performance**	1 to 10	7	7	$50,000	$100,000	$50,000	$100,000
	✓	Credit 2	**On-Site Renewable Energy**	1 to 3		2			$294,000	$359,400
✓	✓	Credit 3	**Enhanced Commissioning**	1	1	1	$16,700	$22,500	$16,700	$22,500
	✓	Credit 4	**Enhanced Refrigerant Management**	1		1			$5,000	$20,000
✓	✓	Credit 5	**Measurement & Verification**	1	1	1	$3,000	$8,000	$3,000	$8,000
		Credit 6	**Green Power**	1						
C	S									
0	0		**Materials & Resources**	13 Points	0	2	$0	$46,000	$0	$123,900
✓	✓	Prereq 1	**Storage & Collection of Recyclables**	Required			$0	$46,000	$0	$46,000
		Credit 1.1	**Building Reuse**, Maintain 75% of Existing Walls, Floors & Roof	1						
		Credit 1.2	**Building Reuse**, Maintain 100% of Existing Walls, Floors & Roof	1						
		Credit 1.3	**Building Reuse**, Maintain 50% of Interior Non-Structural Elements	1						
		Credit 2.1	**Construction Waste Management**, Divert 50% from Disposal	1						
		Credit 2.2	**Construction Waste Management**, Divert 75% from Disposal	1						
		Credit 3.1	**Materials Reuse**, 5%	1						
		Credit 3.2	**Materials Reuse**,10%	1						
	✓	Credit 4.1	**Recycled Content**, 10% (post-consumer + ½ pre-consumer)	1		1			$0	$27,900
		Credit 4.2	**Recycled Content**, 20% (post-consumer + ½ pre-consumer)	1						
	✓	Credit 5.1	**Regional Materials**, 10% Extracted, Processed & Manufactured Regi	1		1			$0	$50,000
		Credit 5.2	**Regional Materials**, 20% Extracted, Processed & Manufactured Regi	1						
		Credit 6	**Rapidly Renewable Materials**	1						
		Credit 7	**Certified Wood**	1						

Table 4-1: Cost Estimate for Sisseton ACF (Continued on Following Page)

c	s									
0	0	**Indoor Environmental Quality**		15 Points	11	12	$7,600	$71,100	$7,600	$231,000
✓	✓	Prereq 1	**Minimum IAQ Performance**	Required			$0	$0	$0	$0
✓	✓	Prereq 2	**Environmental Tobacco Smoke (ETS) Control**	Required			$0	$0	$0	$0
✓	✓	Credit 1	**Outdoor Air Delivery Monitoring**	1	1	1	$3,000	$3,600	$3,000	$3,600
✓	✓	Credit 2	**Increased Ventilation**	1	1	1	$2,000	$5,000	$2,000	$5,000
✓	✓	Credit 3.1	**Construction IAQ Management Plan**, During Construction	1	1	1	$300	$1,500	$300	$1,500
✓	✓	Credit 3.2	**Construction IAQ Management Plan**, Before Occupancy	1	1	1	$1,000	$3,000	$1,000	$3,000
✓	✓	Credit 4.1	**Low-Emitting Materials**, Adhesives & Sealants	1	1	1	$0	$1,600	$0	$1,600
✓	✓	Credit 4.2	**Low-Emitting Materials**, Paints & Coatings	1	1	1	$0	$21,100	$0	$21,100
✓	✓	Credit 4.3	**Low-Emitting Materials**, Carpet Systems	1	1	1	$0	$14,300	$0	$14,300
	✓	Credit 4.4	**Low-Emitting Materials**, Composite Wood & Agrifiber Products	1		1			$0	$159,900
✓	✓	Credit 5	**Indoor Chemical & Pollutant Source Control**	1	1	1	$1,300	$11,000	$1,300	$11,000
✓	✓	Credit 6.1	**Controllability of Systems**, Lighting	1	1	1	$0	$10,000	$0	$10,000
		Credit 6.2	**Controllability of Systems**, Thermal Comfort	1						
✓	✓	Credit 7.1	**Thermal Comfort**, Design	1	1	1	$0	$0	$0	$0
✓	✓	Credit 7.2	**Thermal Comfort**, Verification	1	1	1	$0	$0	$0	$0
		Credit 8.1	**Daylight & Views**, Daylight 75% of Spaces	1						
		Credit 8.2	**Daylight & Views**, Views for 90% of Spaces	1						
c	s									
0	0	**Innovation & Design Process**		5 Points	2	2	$0	$0	$0	$0
		Credit 1.1	**Innovation in Design**: SS5.1-Restore 75% of Site	1						
		Credit 1.2	**Innovation in Design**: SS5.2-Provide 2x Bldg Footprint as open space	1						
		Credit 1.3	**Innovation in Design**: SS7.1-100% Hardscape meets requirements	1						
✓	✓	Credit 1.4	**Innovation in Design**: SS7.2-SRI 78 for 100% of roof surface	1	1	1	$0	$0	$0	$0
✓	✓	Credit 2	**LEED® Accredited Professional**	1	1	1	$0	$0	$0	$0
c	s									
0	0	**Project Totals** (pre-certification estimates)		69 Points	29	36	$125,700	$452,900	$544,700	$1,213,500
				+ Administrative Costs:			$45,000	$55,000	$45,000	$55,000
				TOTAL:			$170,700	$507,900	$589,700	$1,268,500
		Certified 26-32 points **Silver** 33-38 points **Gold** 39-51 points **Platinum** 52-69 points					1.0%	3.0%	3.5%	7.6%

Table 4-1: Cost Estimate for Sisseton ACF (Continued from Previous Page)

The checklist shows which credits could be selected for the Sisseton project, if the design was pursuing a LEED certification. The green column represents the data, which pertains to pursuit of a LEED-Basic certification whereas the grey columns contain data relevant to a LEED-Silver certification. As stated earlier, three points were added to the minimum, in order to ensure sufficient credits would be earned in pursuit of each certification. Hence, 29 points are sought for a Basic certification (minimum 26 required), and 36 points are sought for a Silver certification (minimum 33 required). The final columns contain cost data from Table 2-2, including the low and high capital cost impacts. These are summed for each credit classification (e.g. Sustainable Sites, Water Efficiency, etc,) and finally for all points. Administrative costs are added to account for registration & certification fees, administrative efforts to prepare and submit documentation, and a preliminary A/E evaluation of LEED strategies early in the design process.

This analysis shows that a LEED-Basic certification would add a premium of approximately $191,000 to $548,000 to the capital cost. Inasmuch as the current design for the building is $16,750,000 this represents an increase of 1.1-3.3%. Similarly, a LEED-Silver certification is estimated to add a premium of $606,000 to

$1,290,000, which represents a 3.6-7.7% increase compared to the original construction budget.

Life cycle costs can be summed in a similar fashion. This results in the following cost premiums:

> LEED-Basic Certification: ($133,300) to $150,500
> LEED-Silver Certification: ($183,400) to $118,500

According to this analysis, under the "low" cost scenario, a basic LEED certification could realize potential savings. A LEED-Silver certification also presents the potential for life cycle savings. These potential savings are achieved through reductions in future energy use, attained through pursuit of credits EA1 (Optimize Energy Performance,) and SS7.2 (Heat Island Effect, Roof.) In the LEED-Silver certification scenario, additional savings are realized through pursuit of credit EA2 (Onsite Renewable Energy.) The potential life cycle cost savings for these credits are enumerated in Appendix C.

Comparison to GSA Study

The GSA study, dated October 2004[1] contains a summary of credits most desirable for pursuit of different certification levels, similar to this report. For purposes of comparison and validation, a summary of both studies is provided in Table 4-2. In particular, this table contains a compendium of all possible LEED credits, and identifies which credits were chosen for pursuit of a LEED-Basic certification. This table does not contain specific cost data for each chosen credit, nor does it contain information regarding additional credits chosen for pursuit of a Silver or Gold certification. However, the fields are color-coded to indicate a range in costs estimated, both by GSA and IHS ("low" cost scenario in both cases.) This provides a quick basis for comparing 1) similarity of credits selected, and 2) proximity of cost estimates between this study and GSA's.

It is important to note again that the GSA study investigated two building models: 1) a new mid-rise courthouse (262,000 GSF) and 2) a mid-rise office building modernization (306,000 GSF.) Table 4-2 contains GSA data on the mid-rise courthouse model only, as it is more comparable to the IHS building model. Despite every effort to compare studies on an equivalent basis, it is not possible to make an exact comparison. For example, the courthouse model is based on an urban setting, it comprises significantly more gross square feet of building space than the IHS-Sisseton facility (economy of scale benefits in the GSA case,) and the GSA study evaluates synergistic credit scenarios (i.e. pursuit of one credit facilitates achievement of additional credits at a reduced cost.)

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[1] GSA, *LEED Cost Study – Final Report*, October 2004,

Summary Comparison
GSA[1.,2.] versus IHS[3.]

SS	SUSTAINABLE SITES	GSA	IHS
SS-P1	**Construction Activity Pollution Prevention**	PRE.	PRE.
SS1	**Site Selection**	1	
SS2	**Development Density & Community Connectivity**	1	
SS3	**Brownfield Redevelopment**	1	
SS4.1	**Alternative Transportation:** Public Transportation Access	1	
SS4.2	**Alternative Transportation:** Bicycle Storage & Changing Rooms		1
SS4.3	**Alternative Transportation:** Low Emitting & Fuel Efficient Vehicles		
SS4.4	**Alternative Transportation:** Parking Capacity		1
SS5.1	**Site Development:** Protect or Restore Habitat	1 1	
SS5.2	**Site Development:** Maximize Open Space	1	
SS6.1	**Stormwater Design:** Quantity Control	1 1	1
SS6.2	**Stormwater Design:** Quality Control		
SS7.1	**Heat Island Effect:** Non-Roof	1	
SS7.2	**Heat Island Effect:** Roof	1	1
SS8	**Light Pollution Reduction**	1	1
	SS Totals (14 Possible Points)	10	5

WE	WATER EFFICIENCY	GSA	IHS
WE1.1	**Water Efficient Landscaping** Reduce by 50%	1 1	1
WE1.2	**Water Efficient Landscaping** No Potable Water Use or No Irrigation	1 1	1
WE2	**Innovative Wastewater Technologies**		
WE3.1	**Water Use Reduction** 20% Reduction	1	
WE3.2	**Water Use Reduction** 30% Reduction		
	WE Totals (5 Possible Points)	3	2

KEY

- Measures that are met by existing mandates (no premium)
- Measures with no cost premiums, or potential cost decreases
- Measures with low cost premiums (<$0.20/GSF)
- Measures with moderate cost premiums ($0.20 - $0.60/GSF)
- Measures with high cost premiums (>$0.60/GSF)
- Measures that are situational, or not applicable to the project
- Measures not pursued, although technically feasible

1 Synergistic Credit Tag

EA	ENERGY AND ATMOSPHERE	GSA	IHS
EA-P1	**Fundamental Commissioning of the Building Energy System**	PRE.	PRE.
EA-P2	**Minimum Energy Performance**	PRE.	PRE.
EA-P3	**Fundamental Refrigerant Management**	PRE.	PRE.
EA1	**Optimize Energy Performance**	1	7
EA2	**On-Site Renewable Energy**		
EA3	**Enhanced Commissioning**	1	1
EA4	**Enhanced Refrigerant Management**		
EA5	**Measurement & Verification**		1
EA6	**Green Power**		
	EA Totals (17 Possible Points)	2	9

MR	MATERIALS AND RESOURCES	GSA	IHS
MR-P1	**Storage & Collection of Recyclables**	PRE.	PRE.
MR1.1	**Building Reuse** Maintain 75% of Existing Walls, Floors & Roof		
MR1.2	**Building Reuse** Maintain 95% of Existing Walls, Floors & Roof		
MR1.3	**Building Reuse** Maintain 50% of Interior Non-Structural Elements		
MR2.1	**Construction Waste Management** Divert 50% From Disposal		
MR2.2	**Construction Waste Management** Divert 75% From Disposal		
MR3.1	**Materials Reuse** 5%		
MR3.2	**Materials Reuse** 10%		
MR4.1	**Recycled Content** 10% (post-consumer +1/2 pre-consumer)	1	
MR4.2	**Recycled Content** 20% (post-consumer +1/2 pre-consumer)	1	
MR5.1	**Regional Materials** 10% Extracted, Processed & Manufactured Regionally	1	
MR5.2	**Regional Materials** 20% Extracted, Processed & Manufactured Regionally	1	
MR6	**Rapidly Renewable Materials**		
MR7	**Certified Wood**		
	MR Totals (13 Possible Points)	4	0

Notes

1. GSA Data taken from "GSA LEED Cost Study - Final Report", October 1999
2. GSA Data in this table uses Scenario "1A" (New Courthouse, "Certified" Rating, "Low" Case)
3. IHS Data is based on "low" cost figures, using credits pursued for Basic certification

EQ	INDOOR ENVIRONMENTAL QUALITY	GSA	IHS
EQ-P1	**Minimum IAQ Performance**	PRE.	PRE.
EQ-P2	**Environmental Tobacco Smoke (ETS) Control**	PRE.	PRE.
EQ1	**Outdoor Air Delivery Monitoring**		1
EQ2	**Increased Ventilation**	1	1
EQ3.1	**Construction IAQ Management Plan** During Construction		1
EQ3.2	**Construction IAQ Management Plan** Before Occupancy		1
EQ4.1	**Low-Emitting Materials** Adhesives & Sealants	1	1
EQ4.2	**Low-Emitting Materials** Paints & Coatings	1	1
EQ4.3	**Low-Emitting Materials** Carpet Systems	1	1
EQ4.4	**Low-Emitting Materials** Composite Wood & Agrifiber Products		
EQ5	**Indoor Chemical & Pollutant Source Control**	1	1
EQ6.1	**Controllability of Systems** Lighting		1
EQ6.2	**Controllability of Systems** Thermal Comfort	1	
EQ7.1	**Thermal Comfort** Design	1	1
EQ7.2	**Thermal Comfort** Verification	1	1
EQ8.1	**Daylight & Views** Daylight 75% of		
EQ8.2	**Daylight & Views** Views for 90% of		
	EQ Totals (15 Possible Points)	8	11

ID	INNOVATION AND DESIGN PROCESS	GSA	IHS
ID1.1	**Innovation in Design** Option 1		
ID1.2	**Innovation in Design** Option 2		
ID1.3	**Innovation in Design** Option 3		
ID1.4	**Innovation in Design** Option 4		1
ID2	**LEED Accredited Professional**	1	1
	ID Totals (5 Possible Points)	1	2
	CASE STUDY TOTALS	28	29

Table 4-2: Summary Comparison – GSA vs. IHS LEED Studies

Discussion of Table 4-2

A study of Table 4-2 reveals considerable similarities between the two studies (GSA and IHS,) with several notable exceptions. Generally speaking, both studies approach the LEED certification process in a similar manner: choose the least costly credits first. Both studies also identify which credits are already being achieved through standard practices. The differences between the studies are few, but are worthy of discussion in order to establish issues unique to IHS when pursuing LEED certification under a typical scenario. These differences are addressed in the following paragraphs, identified according to the individual credits where exceptions are noted.

SS4.2 – Alternative Transportation, Bicycle Storage and Changing Rooms
The key difference between the two studies is the differing construction scenarios. In the GSA study, bicycle storage was added to program, inasmuch as it was assumed not to exist under the base model assumption. Furthermore, the court house model is based on urban construction; hence additional space had to be added in the parking area to provide sufficient bicycle storage space. In the IHS model, sufficient land is available to provide such storage space at virtually no additional cost. It was also assumed under the IHS scenario that changing rooms were available at no additional cost within standard Employee Facilities.

SS4.4 Alternative Transportation, Parking Capacity
The GSA study chose not to pursue this credit, inasmuch as under a typical courthouse scenario, parking is severely restricted due to security concerns. The IHS study considered this to be a practical and inexpensive credit, because local zoning ordinances do not apply at an IHS facility (Federally-owned, rural setting.) Also, parking spaces are typically determined by a formula, based on patient and employee data. This number is rarely exceeded, inasmuch as the Program of Requirements (POR) prevents the design from exceeding this number.

SS7.1 Heat Island Effect: Non-Roof
The GSA study determined this to be a relatively inexpensive credit to pursue, and hence chose it on this basis. The main reason for this is the fact that the courthouse model is based on an urban environment, where at least 50% of the parking spaces are provided underground. This is a very different scenario for IHS where the rural setting allows for development of parking spaces in the form of outdoor parking lots, which provide considerable hardscape areas, which are very expensive to replace with high albedo concrete. For this reason, the IHS study did not pursue this credit.

EA1 Optimize Energy Performance
In the GSA study, considerable efforts were placed in the determination of costs. It examined the energy efficiencies of high-performance glazing, roofs and opaque walls with high R values, adjustments to lighting power densities, etc. The IHS study took a very different approach. Since the Sisseton ACF was designed using a ground source heat pump, the optimal geographic and geological conditions allowed for considerable energy savings at a reasonable price. Furthermore, the first two available points under this credit were assumed to be standard practice inasmuch as typical IHS design exceeds ASHRAE 90.1 by at least 14% - the required savings to achieve these two points. In fact, the high efficiency of the ground source heat pump resulted in projected savings of 34% - sufficient to attain seven (7) points. Although this places a high premium on the building, the projected savings will offset these expenses after a few years of operation.

EQ4.4 Low-Emitting Materials, Composite Wood and Agrifiber Products
Although neither study considered this credit as feasible enough to select in pursuit of basic LEED certification, the cost data was significantly different. Part of this is based on the premises of each study. In the case of IHS, there is limited casework in a typical facility. This is quite the opposite in a GSA courthouse, which uses considerable casework. To purchase substrates free of urea formaldehyde yields a significant cost premium in the GSA study whereas the IHS study estimated little impact.

<u>Overall Comparison of Cost Impacts – GSA vs. IHS</u>

The results from both studies are worthy of comparison. Both studies used a common approach for estimating costs, and hence can be associated with reasonable accuracy. By doing so, credibility is enhanced as well, because each study was developed independently.

Each study derived a range of costs, specific to a certification level. Thus, the following graph (Figure 4-1) contains horizontal bars, which represent the range in cost factors, expressed in terms of dollars per square foot as well as percentage of the total construction budget.

Although the percentage factors are not perfectly transferable to any IHS facility construction project (i.e. regardless of size, geographic location, facility function, etc,) they are considered to be a good method for estimating approximate impacts when pursuing a certification.

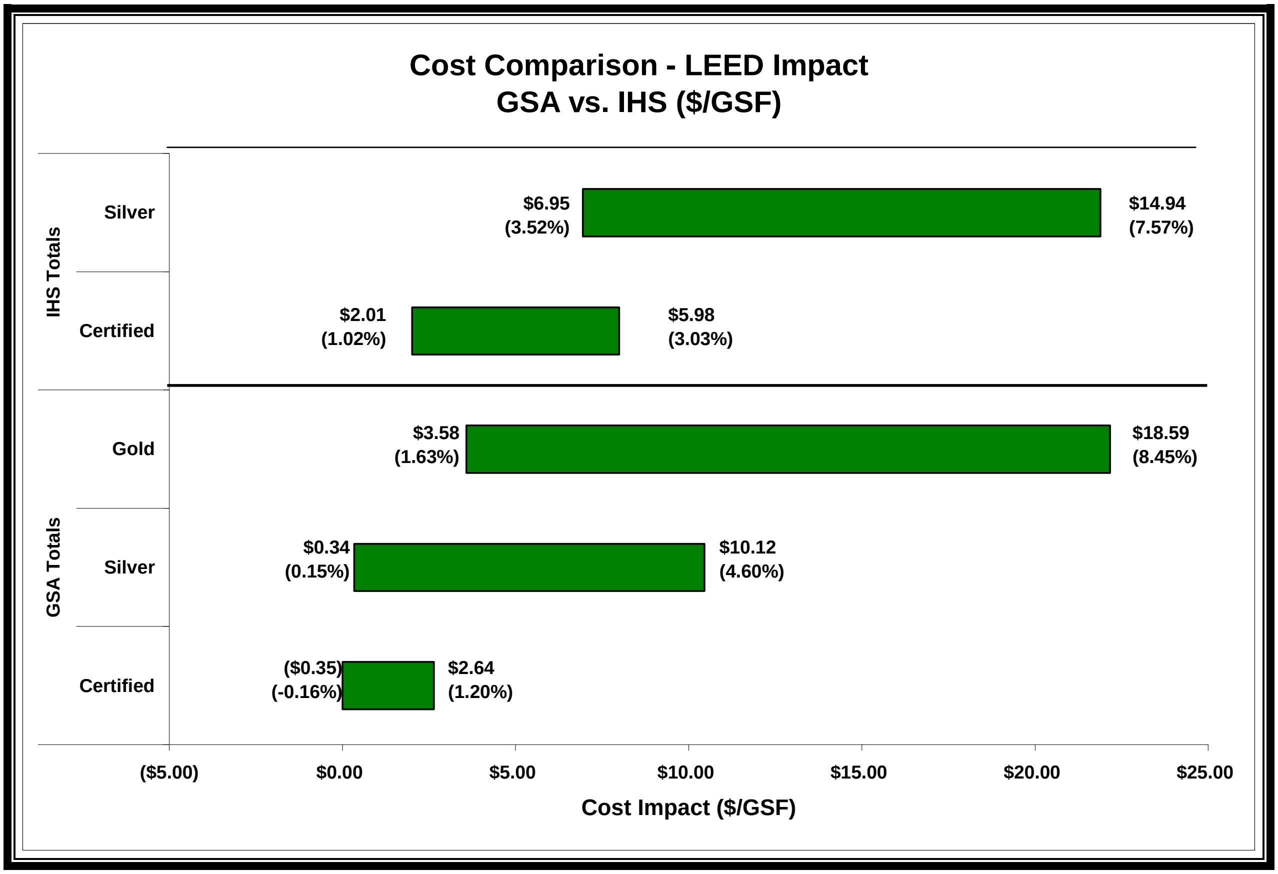

Figure 4-1: Cost Comparison between GSA and IHS LEED Studies

Figure 4-1 provides several insights into the differences as well as similarities between the results of the studies. Most notable is that the anticipated IHS cost impacts are higher than those predicted in the GSA study. In fact, the IHS numbers for Certified are similar to GSA's numbers for Silver, and similarly, the IHS impacts for Silver are comparable to GSA's Gold impacts. The reasons for these differences are various, and listed below:

- The GSA study uses a larger building (i.e. 5-story courthouse,) which benefits from economy-of-scale elements. For example, a multi-story building has less roof space per square foot, and hence can see modifications to the roof, which have a smaller unit cost than a typical 1-2 story IHS facility.
- The IHS typically builds in rural environments. This eliminates several potential urban-based credits, which are easily achievable in the GSA study. Examples of this include *SS2 – Development Density and Community Connectivity and SS4.1 – Alternative Transportation, Public Transportation Access*.
- The GSA study accounts for synergistic credit factors (i.e. achievement of one credit resulted in a reduced cost to achieve additional credits.) These synergistic credits are annotated with a yellow flag in Table 4-2. In

the IHS study by contrast, each credit was evaluated independently so as to be more conservative in determining overall costs.

- In the IHS study, credit *EA2 – On-site Renewable Energy* was selected for the Silver certification model. This is a very conservative approach inasmuch as it is very costly and assumes that no credits are available under Tier 6 – Situational. Because the cost data was set up with the first two (of three possible) points clustered together, the actual points sought in the IHS Silver certification model was *36* – one point more than the GSA model for Silver certification.

Although the cost premiums are higher in the IHS study, they fall within a reasonable range when compared to the GSA study. This places greater validity in the results.

Conclusions

In an effort to comply with the precepts of sustainable design, it is advisable for IHS to adopt the LEED template. The reasons include: it provides a measurable benchmark for determining success, it is widely known, it has significant credibility, and it provides recognition for the agency, affiliated tribes, and communities. Moreover, the LEED process is very flexible, allowing applicants to pursue disparate avenues for achieving a certification. Because IHS facilities are for a very specific purpose, it is vital to have a system, which allows this flexibility in order to accomplish the principles of sustainable design without sacrificing the vital mission of each IHS facility.

Every facility is unique, thus the impacts and benefits of a LEED certified facility are specific to each project. However, many broad generalizations can be made as a result of this study. Some credits are more desirable to pursue than others. These are identified in Section 2 of this report, specifically in Table 2-2.

There is an anticipated cost impact of between 1.0 and 7.6 %, depending on the level of certification desired. A 3.0% increase to the construction budget would be appropriate to pursue a basic LEED certification. Over a 20-year life cycle, there is a potential for savings in the O&M budget – principally in the form of energy savings. This is particularly true where energy rates are expected to see a significant rise in the coming years. In fact, under some scenarios, the energy savings realized over a 20-year period may be sufficient to offset the initial cost premium to achieve LEED certification during construction.

When selecting a strategy for pursuit of a LEED certification project specific characteristics must be evaluated to determine the best path. The data in this report is intended to initiate and facilitate the evaluation process.

Works Cited

Steven Winter & Associates, Inc. "GSA LEED® Cost Study – Final Report" October 2004 <http://www.wbdg.org/newsevents/news_040105.php>

U.S. Green Building Council, "LEED-NC for New Construction – Reference Guide, Version 2.2, First Edition," October 2005

Leo A. Daly, "LEED Energy Study – Replacement Facility, Sisseton Health Center," 16 Dec 2005

Ruzzin, Mark, "Case Study: Boulder Community Foothills Hospital," Ecostructures, September 2004, p. 9

Boulder Community Hospital, "Firsts and Awards" <http://www.bch.org/aboutbch/environmentalprograms.cfm/Firsts and Awards>

U.S. Dept. of Commerce – Weather Bureau, "Rainfall Frequency Atlas of the United States for Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years," May 1961 <http://www.weather.gov/oh/hdsc/On-line_reports/Technical Paper No. 40/Rainfall Frequency Atlas of the US for durations from 30 minutes to 24 hours and return periods 1 to 100 years/1964/Complete.djvu>

Claytor and Schueler, "Method for Computing Peak Discharge for Water Quality Storm," 1996 <http://www.mde.state.md.us/assets/document/sedimentstormwater/Appnd_D10.pdf>

Matthiessen, Lisa Fay and Morris, Peter, "Costing Green: A Comprehensive Cost Database and Budgeting Methodology," July 2004 <http://www.davislangdon.com/pdf/USA/2004CostingGreen.pdf>

Section 5:

Appendix

Contents:

Appendix A:
Case Study: Boulder Community Foothills Hospital

Introduction

Boulder Community Foothills Hospital (BCFH) is a 60-bed hospital which opened in September, 2003. The three-story, 200,000-square-foot facility was the first hospital in the U.S. to earn the LEED certification, achieving a “Silver” rating. Because IHS is pursuing LEED certification in its new hospital construction, the data on this facility is especially relevant.

In this appendix, the history, community profile, budget, program needs, and other specifics surrounding the LEED certification process will be enumerated. This will highlight issues unique to health care facilities, and underscore issues common with other facility types.

Background and History

The community of Boulder, Colorado is known for its environmentally-friendly history. In fact, BCFH was not the first LEED-certified building in the community. This was accomplished with the renovation of the city’s North Boulder Recreation Center[1]. The Boulder Community Hospital (BCH) is a non-profit organization which added a second hospital to its operations in 2003. The decision to pursue LEED certification was based on BCH management’s long-term commitment to the environment. In the past, BCH had purchased wind power for its facilities, and has a full-time environmental coordinator on staff. Furthermore, BCH has had an established recycling program since the mid-1980s, which earned the hospital the 2001 “Recycler of the Year” award from the Colorado Association for Recycling.

The decision to construct the Boulder Community Foothills Hospital was based on the need to meet growing demands combined with the inability to expand its current campus.

Facility Summary

BCFH is a 222,000-square-foot, comprehensive 60-bed hospital that includes 24-hour emergency care services, an intensive care unit; and surgery, radiology,

[1] Ruzzin, Mark, Case Study: Boulder Community Foothills Hospital, *Ecostructures*, September, 2004, p. 9

and laboratory services. Also included are maternity care and pediatrics. Two medical office buildings are also part of the new campus. The overall project cost (excluding land costs,) was $45.6 million. The hospital was opened to the public in September 2003.

The land purchased for this facility consists of a 49-acre parcel that continued to function as a cow pasture even as Boulder's high-tech industrial base was built around it. In order to remove the building from the 500-year flood plain, fill excavated from a downtown underground parking garage was trucked to the site at no cost to BCH.

The principal design firms included Architectural Energy Corporation (AEC,) Oz Architecture (core and shell,) and Boulder Associates (medical architecture.)

Design Process

In order to pursue a certification, the team adopted LEED criteria during the schematic design process, and was frequently used as a basis for evaluating the design decisions. This resulted in numerous iterations, which eventually led to the formal decision to pursue LEED certification. AEC had the primary role of LEED coordination on the project.

Decisions had to be made very early in the design process. Several points fell off the table not long after design initiation. One example was the elimination of electric eye faucets in patient areas. The reason for this was limited functionality in terms of temperature control, filling of basins, bathing newborns, and the dry use of sinks for such things as medication mixing[2].

One of the primary challenges was to decide which technologies to pursue, and which ones to abandon. Because many of these technologies did not have a substantial history, it was difficult to choose them.

[2] Ibid, p. 3

<u>Design Elements Pursued for LEED Certification</u>

In the end, BCFH earned 33 points, qualifying for a Silver certification level. The credits pursued are listed below, including a narrative of features that helped to meet the intent of the respective credits:

<u>Sustainable Sites</u>

SS5.2 The hospital's footprint, including hardscape and landscape rests on 17 acres, only 35% of the 49-acre parcel.

SS5.1 The 32 acres on the parcel is dedicated as open space through a conservation easement, and prairie dogs have replaced cows as the primary inhabitants of this land.

SS4.1 The hospital is located within close proximity to high-frequency transit service, and employees were provided with transit passes.

SS4.2 Bicycle storage and changing rooms with easy access to showers is provided for employees.

SS4.3 The parking lots have charging stations for electric cars.[3]

SS4.4 The parking lot is sized to provide 25% fewer spaces than required, and parking spaces are dedicated for carpools.

SS7.2 BCFH employs an R-30 ENERGY STAR® -rated cool roof to reduce the buildings heat-island effect.

<u>Water Efficiency</u>

WE1.1 BCFH incorporates xeriscaping into its landscaping plan, reducing the hospital's irrigation water requirements by more than 50%.

WE2 The hospital is experimenting with waterless urinals, however only in public restrooms which also incorporate electric eye faucets. Because this is not a permanent design fixture, no LEED credits were achieved for this effort.

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[3] Boulder Community Hospital, *Firsts and Awards,* http://www.bch.org/aboutbch/environmental programs.cfm?firsts%20and%20Awards

Energy Efficiency

EA1 Numerous energy-efficiency measures include high-efficiency glazings, T5 lamps, occupancy sensors, building shading devices, variable speed high-efficiency chillers, high-efficiency fans and fan motors, outside air economizers, and high-efficiency lighting controls result in a 27.6% savings above ASHRAE 90.1 – sufficient to earn 5 points.

Materials & Resources

MR2.1 Construction waste was diverted from landfills, achieving a 64% recycling rate.

MR4.1 Recycled content building materials were utilized to a large extent. One example of this is fly ash to enhance field performance. Fly ash dosage varied from 0% to 25% of cementious materials.[4]

MR5.1 Many of the construction materials, mostly in the façade, were derived from local suppliers (brick and sandstone.)

Indoor Environmental Quality

EQ3.1 & EQ3.2

BCFH implemented an indoor air quality management plan for the construction and pre-occupancy phases of building construction. This included a two-week building flush-out using 100 percent outside air after construction ended.

EQ6.2 A temperature and humidity monitoring system was installed to provide control over thermal-comfort performance.

EQ1 A CO_2 monitoring system ensures indoor air maintains consistently healthy oxygen levels.

EQ4.1, 4.2, 4.3 & 4.4

Low-VOC finishing materials were used, including adhesives and sealants, paints and coatings, and carpet. Formaldehyde-free composite wood products were also used.

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[4] Portland Cement Association, *Boulder Community Foothills Hospital – Green and Silver Concrete Hospital*, http://www.cement.org/buildings/buildings_green_boulder.asp

EQ6.1 Daylighting strategies were implemented in the design to provide natural lighting to patients, staff, and visitors.

<u>Lessons Learned</u>

Because BCFH was able to obtain a LEED-Silver certification, the message is clear: green building principles can be applied in health care settings, much to the satisfaction of the communities involved, and the patients whom they serve. Although specific cost impacts for this project weren't identified from any of the sources sought in this study, it was revealed that the payback for the facility is 12-years. Presumably, this is due to the energy savings predicted, based upon energy modeling.

As a public institution, a longer payback was palatable to the stakeholders. In the private sector, where long-term financial commitments are more risky, this may be a more difficult thing to adopt when selecting how best to invest funds for a facility.
The experiences gained through pursuit of a LEED certification are valuable for those who follow. Overall, sustainable building principles can be attained without resorting to high-profile, highly technical, speculative technologies. According to BCH, the facility has "very little 'wow' factor when it comes to what makes it green. The sustainability is in the little things – the things you don't see, the things you don't notice."[5]

It would seem that the experience of the Boulder Community Foothills Hospital is quite consistent with the findings of this paper.

[5] Ruzzin, op. cit., p. 10

Appendix B:
Detailed Capital Cost Estimates for LEED Credits

Estimates Contained in this Appendix

Site Selection

Water Efficiency

Energy & Atmosphere

Materials & Resources

Indoor Environmental Quality

Innovation in Design

Cost Estimate
Credit SS1 - Site Selection

Capital Cost Impact

Assumptions

1. Due to the preponderance of prime farmland in Roberts County, SD, the only plausible way to achieve this credit is to develop within the city of Sisseton, SD.
2. Assume property within Sisseton costs $10k/acre
3. Assume a 50% increase in cost over the land actually purchased (in the county.)
4. For a "minimum cost" scenario, it will be assumed that "less desireable" land within city limits can be purchased for only 10% more than the land already purchased (in the county.)
5. Permits, regulations, etc. will impose a 20% surcharge on the property cost.

Maximum Cost

Item	Description	QTY	Unit	Unit Cost	Total Cost
1.	Property	15	AC	$10,000	$150,000
2.	Permits, Regulations Surcharge	1	EA	$30,000	$30,000
3.	Minus cost of Existing Land	15	AC	-$5,000	-$75,000
		Total Cost, Site Selection:			**$105,000**

Minimum Cost

1.	Property	15	AC	$5,500	$82,500
2.	Permits, Regulations Surcharge	1	EA	$16,500	$16,500
3.	Minus Cost of Existing Land	15	AC	-$5,000	-$75,000
		Minimum Cost, Site Selection:			**$24,000**

Cost Estimate
Credit SS3 - Brownfield Redevelopment

Capital Cost Impact

<u>Assumptions</u>

1. For informational purposes, the "maximum cost" scenario will assume underground soil contamination
2. For the assumed contamination case, a plume of light petroleum contamination will be considered
3. The plume will begin at the surface, and comprise 5,000 cubic yards (ellipsoid having radial dimensions of 25',50', and 25')
4. For a "minimum cost" scenario, it will be assumed that soil can be treated on site through windrowing, and that no hazards exist to the occupants.
5. A minimal volume of 1,000 cubic yards (at the surface) is assumed for the "minimum cost" scenario.

Maximum Cost

Item	Description	QTY	Unit	Unit Cost	Total Cost
1.	Soil Analysis	1	LS	$10,000	$10,000
2.	Monitoring Wells	50	EA	$1,500	$75,000
3.	Permits, Remediation Plan	1	LS	$2,500	$2,500
4.	Excavation	5000	CY	$6	$30,000
5.	Hauling	10000	EA	$3	$30,000
6.	Offsite Treatment	5000	CY	$25	$125,000
7.	Imported Soil	5000	CY	$2	$7,500
8.	Backfilling	5000	CY	$10	$50,000
	Total Cost, Brownfield Redevelopment:				**$330,000**

Minimum Cost

1.	Soil Analysis	1	LS	$10,000	$10,000
2.	Monitoring Wells	10	EA	$1,500	$15,000
3.	Permits, Remediation Plan	1	LS	$1,500	$1,500
4.	Excavation	1000	CY	$6	$6,000
5.	Fencing & Signage	1	LS	$10,000	$10,000
6.	Seeding	1	LS	$1,500	$1,500
	Minimum Cost, Brownfield Redevelopment:				**$44,000**

Cost Estimate

Credit SS4.2 - Alternative Transportation - Bicycle Storage & Changing Rooms

Capital Cost Impact

Assumptions

1. Although the Health Center contains more than enough shower/changing facilities to accommodate 9 people, no bicycle racks are provided.
2. Garages are required for these quarters which could be adapted to meet the requirement for covered storage. CIR dated 7/4/2003 requires covered storage to be easily accessible during all periods of the year.
3. RS Means, 2005 Edition, lists the installed cost of a 10 foot bikerack as $600.00.
4. For a "minimum cost" scenario, it will be assumed that these bicycle racks could be incidental to the project, and hence, have no cost.

Maximum Cost

Item	Description	QTY	Unit	Unit Cost	Total Cost
1.	Bicycle Racks, 10-foot, installed	2	EA	$600	$1,200
	Total Cost, Bicycle Storage & Changing Rooms:				**$1,200**

Minimum Cost

Minimum Cost, Bicycle Storage & Changing Rooms: **$0**

Cost Estimate

Credit SS4.3 - Alternative Transportation: Alternative Fuel Vehicles (AFV)

Capital Cost Impact

Assumptions

1. This credit can be achieved by purchasing hybrid vehicles in lieu of conventional internal combustion vehicles
2. Estimated number of vehicles = 3% of FTEs (197) = 6
3. No tax inventives apply in this case.

Item	Description	QTY	Unit	Cost	Cost
1.	Hybrid Vehicle, Premium over Conventional	6	LS	$4,000	$24,000
2.	Employee Training	1	LS	$2,000	$2,000
	Total Cost Impact, Credit SS4.3:				**$26,000**

For a minimum cost scenario, assume a $3500 premium on each vehicle with no employee training ($21,000)

Cost Estimate

Credit SS5.1 - Site Development, Protect or Restore Habitat

Capital Cost Impact

Assumptions

1. Given the total area of the site (14 acres,) one-half of this area would need to be restored (7 acres)
2. Restoration with native or adaptive vegetation will cost approximately $3,000 per acre, plus costs for temporary irrigation required to establish plants.
3. For a "minimum cost" scenario, it will be considered that IHS has chosen a site that has not had native vegetation impacted, and only needs to prevent impacts to 50% of the area (no cost.)

Maximum Cost

Item	Description	QTY	Unit	Unit Cost	Total Cost
1.	Site Restoration, Adaptive Vegetation	7	AC	$3,000	$21,000
	Total Cost, Site Development, Protect or Restore Habitat:				**$21,000**

Minimum Cost

Minimum Cost, Site Development, Protect or Restore Habitat: **$0**

Cost Estimate
Credit SS6.1 - Stormwater Design (Quantity Control)

Capital Cost Impact

Assumptions

1. Stormwater Detention is becoming standard practice
2. Baseline case for Sisseton: assume ***6-month 24-hr*** storm as design parameter
3. To meet SS6.1, a ***2-year 24-hr storm*** is the design parameter
4. Assume pavements will all drain to a detention pond

Maximum Cost

		Quantity			Unit	Total Cost	
Item	**Description**	**Baseline**	**SS6.1**	**Unit**	**Cost**	**Baseline**	**SS6.1**
1.	Stormwater Piping, 16"	500	500	LF	$60	$30,000	$30,000
2.	Manholes	2	2	EA	$2,500	$5,000	$5,000
3.	Excavation	4000	6500	CY	$25	$100,000	$162,500
4.	Hauling	4000	6500	CY	$3	$12,000	$19,500
5.	Flow Control Structures	3	4	EA	$2,500	$7,500	$10,000
6.	Fencing	400	500	LF	$20	$8,000	$10,000
7.	Surveying	50	60	Man-Hr	$45	$2,250	$2,700
8.	Slope Stabilization	5000	7000	SF	$1	$2,500	$3,500
	Cost Subtotal; Stormwater Design, Quantity Control:					$167,250	$243,200 *
	+ Design Cost; 10% of Construction Cost:					$16,725	$24,320
						$183,975	**$267,520**

Maximum Cost Impact; Stormwater Design, Quantity Control (Difference): **$83,545**

* The actual construction cost for the stormwater detention system at Sisseton, according to ESDP Contract Modification No. 2 was $272,920 (underground system)

Minimum Cost

Because the Sisseton Facility was designed to handle stormwater to the degree as required by this credit, the *change* in cost to implement this credit is $0

Cost Estimate

Credit SS6.2 - Stormwater Design (Quality Control)

Capital Cost Impact

Assumptions

1. Drainage Swales (current design) will infiltrate sufficient to treat 10% of design storm.
2. A Retention Pond will be used to treat stormwater
3. The existing underground storage facility will provide no treatment, only flow control.
4. All Excavated Material must be hauled away from site.

Maximum Cost (Retention Pond)

Item	Description	QTY	Unit	Unit Cost	Total Cost
1.	Stormwater Piping, 16"	150	LF	$60	$9,000
2.	Manholes	2	EA	$2,500	$5,000
3.	Excavation	4800	CY	$25	$120,000
4.	Hauling	4800	CY	$3	$14,400
5.	Flow Control Structures	4	EA	$2,500	$10,000
6.	Fencing	600	LF	$20	$12,000
7.	Surveying	60	Man-Hr	$45	$2,700
8.	Slope Stabilization	7000	SF	$1	$3,500
				Cost Subtotal; Stormwater Design, Quality Control:	$176,600
				+ Design Cost, 10% of Construction Cost:	$17,660
				- Cost for Baseline Case (Non-Structural BMPs):	-$70,000
				Maximum Cost Impact; Stormwater Design, Quality Control:	**$124,260**

Minimum Cost (Non-Structural BMPs)

This credit can be achieved through non-structural Best Management Practices (BMPs). Some examples include: drainage swales, porous pavements, vegetated filter strips, disconnection of impervious areas, etc. Where sufficient land is available, this may be feasible (not in this case - Sisseton.) For informational purposes, the development of these BMPs may reduce costs by 50-60%, bringing a *minimum* cost to implement of **$70,000**.

Cost Estimate
Credit SS7.1 - Heat Island Effect, Non-Roof

Capital Cost Impact

Assumptions

1. Credit can be achieved through converting 2080 SY of asphalt paving to concrete paving, and using "white" concrete for all the concrete hardstand. This will make 50% of the total hardsurfaces reflective concrete.
2. Although open grid pavement could meet the requirements of this credit, it is not considered as a viable option inasmuch as the soils in Sisseton are expansive and have low-permeability.
3. To meet this credit with shade tree plantings, approximately 1000 lineal feet of trees would be required. Furthermore, they would need to provide shade that would project 20' into the parking area. For this reason, shading was not considered in this analysis.

Maximum Cost

Item	Description	QTY	Unit	Unit Cost	Total Cost
1.	Cost of Concrete Paving	2080	SY	$24	$49,920
2.	Minus Cost of Asphalt Paving	2080	SY	-$12.20	-$25,376
3.	Additional Cost for White Concrete	1585	CY	$75.00	$118,875

Total Cost, Heat Island Effect, Non-Roof: $143,400

Minimum Cost

1.	Assume 15% discount on "maximum" cost scenario	$121,890
2.	Rounded to Nearest Ten Thousand	$120,000

Minimum Cost, Heat Island Effect, Non-Roof: $120,000

Cost Estimate
Credit SS7.2 - Heat Island Effect, Roof

Capital Cost Impact

Assumptions

1. Due to practicality limitations, vegetated roofs will not be pursued in any case for IHS.

Maximum Cost

Item	Description	QTY	Unit	Unit Cost	Total Cost
1.	PVC Roofing (60 mil, fully adhered)	82000	SF	$1.95	$159,900
2.	EPDM Roofing (60 mil, fully adhered)	82000	SF	-$1.63	-$133,660
				Subtotal:	$26,240
		Rounded up to Nearest $2,500:			$27,500

Total Cost, Heat Island Effect, Roof: $27,500

Minimum Cost

1.	Assume a $5K discount from "Maximum" Cost	$22,500

Minimum Cost, Heat Island Effect, Roof: $22,500

Cost Estimate
Credit SS8 - Light Pollution Reduction

Capital Cost Impact

Assumptions

1. For minimum cost impact, assume occupational sensor switches are included in standard design

Item	Description	QTY	Unit	Unit Cost	Total Cost
1.	Occupational Sensor Switches	162	EA	$75	$12,150
		Subtotal; Light Pollution Reduction:			**$12,150**

Round up to nearest thousand to develop maximum cost impact

Maximum Cost Impact; Light Pollution Reduction:	**$13,000**
Minimum Cost Impact; Light Pollution Reduction:	**$0**

Cost Estimate
Credit WE1.1 - Irrigation Efficiency (Reduce Potable Use by 50%)

Capital Cost Impact

Assumptions

1. This credit can be achieved through replacing 10,000 SF of turfgrass with a grass mix (no irrigation), AND
2. Replace conventional irrigation design with a DRIP system, including moisture sensing technology.
3. Plant species cost the same, therfore no additional costs or savings are realized through changing landscaping.
4. DRIP costs roughly the same to install as conventional sprinklers
5. To ensure efficiency, moisture sensors will be an added cost.

Item	Description	QTY	Unit	Unit Cost	Total Cost
1.	Moisture Sensors	1	LS	$5,000.00	$5,000.00
2.	Enhanced Controls	1	LS	$2,500.00	$2,500.00
3.	Operator Training	1	LS	$3,000.00	$3,000.00

Total Cost, Credit WE1.1: $10,500.00

To bracket the costs, apply a +/- 25% factor to the estimate

Maximum Cost:	**$13,100**
Minimum Cost:	**$7,900**

Cost Estimate

Credit WE1.2 - Irrigation Efficiency (No Potable Use or No Irrigation)

Capital Cost Impact

__**Assumptions**__

1. This credit can be achieved through replacing 25,000 SF of turfgrass with a grass mix (no irrigation), AND
2. Replace conventional irrigation design with a DRIP system, including moisture sensing technology, AND
3. Harvest all rainwater.
4. Plant species cost the same, therfore no additional costs or savings are realized through changing landscaping.
5. DRIP costs roughly the same to install as conventional sprinklers
6. To ensure efficiency, moisture sensors will be an added cost.

Maximum Cost

Item	Description	QTY	Unit	Unit Cost	Total Cost
1.	Moisture Sensors	1	LS	$5,000.00	$5,000
2.	Enhanced Controls	1	LS	$2,500.00	$2,500
3.	Operator Training	1	LS	$3,000.00	$3,000
4.	Underground Storage Tanks, ~10,000 gallons	1	LS	$20,000.00	$20,000
5.	Harvested Water Pumping and Control System	1	LS	$15,000.00	$15,000
6.	Rainwater Collection System	1	LS	$10,000.00	$10,000
				Cost Subtotal, Credit WE1.1:	$55,500
				- Items 1-3 (Included in WE1.1):	-$10,500
				Total Cost Impact, Credit WE1.2:	**$45,000**

Minimum Cost

Assume Xeriscaping is used to earn the credit, which has a cost impact of $0

Cost Estimate

Credit WE2 - Innovative Wastewater Technologies

Capital Cost Impact

Assumptions

1. This credit can be achieved through replacing all water closets and urinals with low-flow water closets and waterless urinals, AND
2. Provide rainwater harvesting to supply 10,000 gallons per year for toilet flushing.
3. Low-Flow and no-flow fixtures (urinals) do not impose an additional cost burden.

Estimated Cost

Item	Description	QTY	Unit	Unit Cost	Total Cost
1.	Operator Training	1	LS	$3,000.00	$3,000.00
2.	Underground Storage Tanks, ~10,000 gallons	1	LS	$20,000.00	$20,000.00
3.	Harvested Water Pumping and Control System	1	LS	$15,000.00	$15,000.00
4.	Rainwater Collection System	1	LS	$10,000.00	$10,000.00
				Total Cost, Credit WE1.1:	**$48,000.00**

Minimum and Maximum Cost

There really is no other alternative to achieving this credit in Sisseton, SD. Hence, the cost range will be developed by using the estimated cost as the average between the two extremes, and calculate them as +/- 10% of the average, and rounding them to the nearest $1,000.

Maximum Cost:	**$53,000.00**
Minimum Cost:	**$43,000.00**

Cost Estimate
Credit EAPR1 - Fundamental Commissioning

Capital Cost Impact

Assumptions

1. Although IHS typically meets this requirement, this is not formalized; hence, this estimate will treat all commissioning costs as a premium to the LEED process.
2. Design costs are assumed to be incidental to any project, and are not considered.

Item	Description	Quantity Min	Quantity Max	Unit	Unit Cost	Total Cost Min	Total Cost Max
1.	Commissioning Authority - General Effort	60	80	HR	$100	$6,000	$8,000
2.	Commissioning Authority - Verify Performance	80	100	HR	$100	$8,000	$10,000
3.	Commissioning Report	1	1	LS	$4,000	$4,000	$4,000
						$18,000	**$22,000**

Maximum Cost Impact; Fundamental Commissioning: **$22,000**

Minimum Cost Impact; Fundamental Commissioning: **$18,000**

Cost Estimate
Credit EA1 - Optimize Energy Performance

Given
Table of Comparison: Conventional HVAC vs. Ground Source Heat Pump (GSHP)

Characteristics	HVAC			GSHP		
	min	max	average	min	max	average
Total Building Energy Use ($ekWh/ft^2/yr$)	12.8	49.4	22.7	8.1	22.3	14.37
Total Building Demand (W/ft^2)	3.46	12.5	7.18	2.31	9.38	4.72
Total Building Energy Costs ($\$/ft^2/yr$)	$0.79	$2.07	$1.28	$0.62	$1.43	$ 1.02
Installed HVAC System Capital Cost ($\$/ft^2$)	$2.19	$13.78	$7.96	$2.67	$16.35	$ 9.32

Capital Cost - Sisseton:

Average GSHP Cost =	$9.32			
Average HVAC Cost =	$7.96			
Difference =	$1.36 per GSF	X	84,895 GSF =	**$115,500**
Minus Mechanical Space Savings				**-$40,000**
Total Cost Premium, First Seven Points:				**$75,500**

Assume $75,000 is the average cost premium for the first seven points
Apply a $25k (33%) adjustment (+/-) to establish maximum and minimum costs

Cost Range

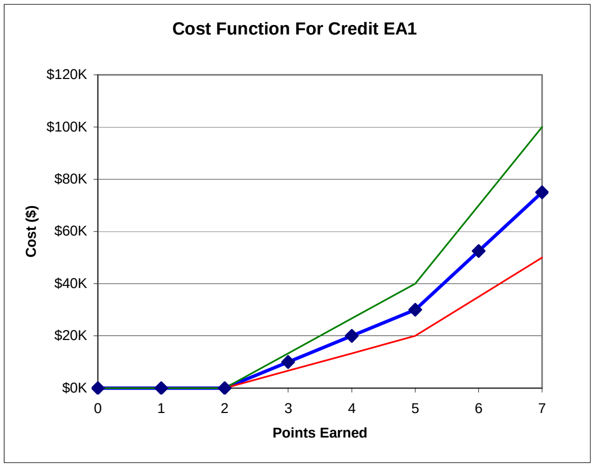
Minimum Cost	**$50,000**
Maximum Cost	**$100,000**

Allocating Costs to Different Point Levels

Rules:
1. First Two Points considered at no cost (standard practice for IHS to invest in energy savings)
2. Next Three Points assumed to be 2/5 the cost for the full seven points
3. Next Two Points extrapolated linearly, such that average cost for GSHP crosses at 7 points
4. Final Three Points not considered in this analysis

m1 = $10,000
m2 = $22,500

LEED Credits	Average	Cost Min.	Max
0	$0	$0	$0
1	$0	$0	$0
2	$0	$0	$0
3	$10,000	$6,700	$13,300
4	$20,000	$13,300	$26,700
5	$30,000	$20,000	$40,000
6	$52,500	$35,000	$70,000
7	$75,000	$50,000	$100,000



Assigned Costs Per Category

	min	max
First Two Points	0	0
Points 3-5	$20,000	$40,000
Points 6-7	$30,000	$60,000

Cost Estimate
Credit EA2 - On-Site Renewable Energy

Capital Cost Impact

Assumptions

1. Unit Cost for Rooftop Photovoltaic System = $9/Wp
2. Generation Capicity Required to Meet Credit = 33 kWp
3. For a "minimum" cost scenario, apply a 15% economic incentive reduction (State of South Dakota)

Maximum Cost

Item	Description	QTY	Unit	Unit Cost	Total Cost
1.	Rooftop Photovoltaic System	33,000	Wp	$9	$297,000
				Subtotal:	$297,000
				+ Design Fees @10%:	$29,700
				Cost Impact:	$326,700

Add 10% to estimate a *maximum* cost impact

Maximum Cost Impact; EA2, Onsite Renewable Energy: $359,370

Minimum Cost

	Unit	Total
Subtract 10% to estimate *minimum* cost impact		

Minimum Cost; EA2, On-Site Renewable Energy: $294,030

Cost Estimate

Credit EA3 - Enhanced Commissioning

Capital Cost Impact

Assumptions

1. Detailed in Cost Data (below)

Item	Description	QTY	Unit	Unit Cost	Total Cost
1.	Commissioning Authority(CA) - Review During Design	16	HR	$100	$1,600
2.	CA Review at CD phase	24	HR	$100	$2,400
3.	Review Construction Submittals	1	LS	$10,000	$10,000
4.	Develop Manual for Re-commissioning	1	LS	$3,200	$3,200
5.	Review O&M with staff	1	LS	$2,400	$2,400
	Subtotal: Enhanced Commissioning				**$19,600**

Apply a +/- 15% factor to develop maximum and minimum cost impacts

Maximum Cost Impact; Enhanced Commissioning: $22,500

Minimum Cost Impact; Enhanced Commissioning: $16,700

Cost Estimate
Credit EA4 - Enhanced Refrigerant Management

Capital Cost Impact

Assumptions

1. Design costs are assumed to be incidental to any project, and are not considered.

Item	Description	Quantity Min	Quantity Max	Unit	Unit Cost	Total Cost Min	Total Cost Max
1.	Selective Refrigerant & Chillers	5000	20000	LS	$1	$5,000	$20,000
						$5,000	**$20,000**

Maximum Cost Impact; Enhanced Refrigerant Management: $20,000

Minimum Cost Impact; Enhanced Refrigerant Management: $5,000

Cost Estimate
Credit EA5 - Measurement and Verification

Capital Cost Impact

Assumptions

1. Design costs are assumed to be incidental to any project, and are not considered.

Item	Description	Quantity Min	Quantity Max	Unit	Unit Cost	Total Cost Min	Total Cost Max
1.	Install DDC Points	6	16	LS	$500	$3,000	$8,000
						$3,000	**$8,000**

Maximum Cost Impact; Measurement & Verification: $8,000

Minimum Cost Impact; Measurement & Verification: $3,000

Cost Estimate

Credit MRPR1 - Storage & Collection of Recyclables

Capital Cost Impact

<u>Assumptions</u>

1. For a facility of this size (between 50k-100k sq. ft,) 225 SF of space is recommended
2. Use unit cost of $200/GSF (current facility estimate)

Maximum Cost

Item	Description	QTY	Unit	Unit Cost	Total Cost
1.	Dedicated Programmed Space	225	SF	$200	$45,000
2.	Recycling Containers, signage, etc.	1	LS	$1,000	$1,000
				Total Cost, Storage & Collection of Recyclables:	**$46,000**

Minimum Cost

Assume that no additional program space; required space will be absorbed by other spaces (e.g. loading dock, general stores, etc.)

Minimum Cost, Storage & Collection of Recyclables: $0

Cost Estimate

Credit MR4.1 - Recycled Content, 10% (post consumer + 1/2 pre consumer)

Capital Cost Impact

Assumptions

1. Max. cost assumed to be a 5% premium above material cost for same.
2. Min. cost assumed to be same as current mat'l cost.

Item	Description	QTY	Unit	Unit Cost	Total Cost
1.	Total Construction Cost	1	LS	$16,750,000	$16,750,000
				Subtotal; Construction Cost:	$16,750,000
				Estimated Total Materials Cost (33% of Construction Cost):	$5,583,333
				Recycled Content (10% of Materials Cost):	$558,333
				5% Premium (of Recycled Materials Content):	$27,917
				Maximum Cost; Low-Emitting Materials, Adhesives & Sealants:	**$27,900**
				Minimum Cost; Low-Emitting Materials, Adhesives & Sealants:	**$0**

Cost Estimate
Credit MR5.1 - Regional Materials, 10% Extracted, Processed & Manufactured Regionally

Capital Cost Impact

Assumptions

1. Max. cost assumed to be a 5% premium above material cost for same.
2. Min. cost assumed to be same as current mat'l cost.
3. Mechanical, Electrical, and Specialties exempt from requirement

Item	Description	QTY	Unit	Unit Cost	Total Cost
	1. Total Construction Cost	1	LS	$16,750,000	$16,750,000
				Subtotal; Construction Cost:	$16,750,000
				Mechanical/Plumbing Costs:	$3,392,920
				Electrical Costs:	$1,881,440
				Specialties Costs:	$250,640
				Subtotal: Eligible Cost:	$5,525,000
				+ Taxes, OH & P @23%:	$1,270,750
				Subtotal; Exempt Costs:	$6,795,750
				Adjusted Subtotal; Construction Cost minus Exempt Costs:	$9,954,250
				Regional Requirement @10%:	$995,425
				Premium on Regional Materials @5%:	$49,771
				Maximum Cost; Low-Emitting Materials, Adhesives & Sealants:	**$50,000**
				Minimum Cost; Low-Emitting Materials, Adhesives & Sealants:	**$0**

Cost Estimate
Credit EQ1 - Outdoor Air Delivery Monitoring

Capital Cost Impact

Assumptions

1. Detailed in Cost Estimate (below)

		Quantity			Unit	Total Cost	
Item	**Description**	**Min**	**Max**	**Unit**	**Cost**	**Min**	**Max**
1.	Design Costs	0	1	LS	$600	$0	$600
2.	CO_2 Sensors	2	2	EA	$500	$1,000	$1,000
3.	Airflow Measuring Devices	4	4	EA	$500	$2,000	$2,000
						$3,000	$3,600

Maximum Cost, Outdoor Air Delivery Monitoring: **$3,600**

Minimum Cost, Outdoor Air Delivery Monitoring: **$3,000**

Cost Estimate
Credit EQ2 - Increased Ventilation

Capital Cost Impact

Assumptions

1. Design costs are assumed to be incidental to any project, and are not considered.

		Quantity			Unit	Total Cost	
Item	**Description**	**Min**	**Max**	**Unit**	**Cost**	**Min**	**Max**
1.	Increase in Construction Costs: larger fan and motor sizes	2000	5000	LS	$1	$2,000	$5,000
						$2,000	$5,000

Maximum Cost, Increased Ventilation: **$5,000**

Minimum Cost, Increased Ventilation: **$2,000**

Cost Estimate

Credit EQ3.1 - Construction IAQ Management Plan, During Construction

Capital Cost Impact

Assumptions

1. Design costs are assumed to be incidental to any project, and are not considered.

Item	Description	Quantity		Unit	Unit	Total Cost	
		Min	Max		Cost	Min	Max
1.	Install temp. MERV-8 Filters	300	1000	LS	$1	$300	$1,000
2.	Protect Mat'ls from Moisture Damage	0	1	LS	$500	$0	$500
						$300	$1,500

Maximum Cost, Increased Ventilation: $1,500

Minimum Cost, Increased Ventilation: $300

Cost Estimate

Credit EQ3.2 - Construction IAQ Management Plan, Before Occupancy

Capital Cost Impact

Assumptions

1. Design costs are assumed to be incidental to any project, and are not considered.

Item	Description	Quantity		Unit	Unit	Total Cost	
		Min	Max		Cost	Min	Max
1.	2 Week Building Flushout (Fuel Costs)	1000	3000	LS	$1	$1,000	$3,000
						$1,000	$3,000

Maximum Cost, Increased Ventilation: $3,000

Minimum Cost, Increased Ventilation: $1,000

Cost Estimate
Credit EQ4.1 - Low-Emitting Materials, Adhesives & Sealants

Capital Cost Impact

Assumptions
1. Max. cost assumed to be a 10% premium above material cost for same.
2. Min. cost assumed to be same as current mat'l cost.

Item	Description	QTY	Unit	Unit Cost	Total Cost
1.	Materials Cost: Interior Adhesives/Sealants	1	LS	$13,000	$13,000
2.	Taxes/OH&P @23%	1	LS	$2,990	$2,990
				Subtotal; Standard Adhesives & Sealants:	$15,990
				10% Premium:	$1,599
				Maximum Cost; Low-Emitting Materials, Adhesives & Sealants:	**$1,600**
				Minimum Cost; Low-Emitting Materials, Adhesives & Sealants:	**$0**

Cost Estimate
Credit EQ4.2 - Low-Emitting Materials, Paints

Capital Cost Impact

Assumptions
1. Max. cost assumed to be a 10% premium above material cost for same.
2. Min. cost assumed to be same as current mat'l cost.

Item	Description	QTY	Unit	Unit Cost	Total Cost
1.	Materials Cost: Interior Paints	1	LS	$171,890	$171,890
2.	Taxes/OH&P @23%	1	LS	$39,535	$39,535
				Subtotal; Standard Adhesives & Sealants:	$211,425
				10% Premium:	$21,142
				Maximum Cost; Low-Emitting Materials, Adhesives & Sealants:	**$21,100**
				Minimum Cost; Low-Emitting Materials, Adhesives & Sealants:	**$0**

Cost Estimate

Credit EQ4.3 - Low-Emitting Materials, Carpets

Capital Cost Impact

Assumptions

1. Max. cost assumed to be a 10% premium above material cost for same.
2. Min. cost assumed to be same as current mat'l cost.

Item	Description	QTY	Unit	Unit Cost	Total Cost
1.	Materials Cost: Carpets	1	LS	$116,170	$116,170
2.	Taxes/OH&P @23%	1	LS	$26,719	$26,719
				Subtotal; Standard Adhesives & Sealants:	$142,889
				10% Premium:	$14,289
				Maximum Cost; Low-Emitting Materials, Adhesives & Sealants:	**$14,300**
				Minimum Cost; Low-Emitting Materials, Adhesives & Sealants:	**$0**

Cost Estimate

Credit EQ4.4 - Low-Emitting Materials, Composite Wood & Agrifiber Products

Capital Cost Impact

Assumptions

1. Max. cost assumed to be a 20% premium above material cost for same.
2. Min. cost assumed to be same as current mat'l cost.

Item	Description	QTY	Unit	Unit Cost	Total Cost
1.	Eligible Materials	1	LS	$650,000	$650,000
				Subtotal; Construction Cost:	$650,000
				+ Taxes, OH & P @23%:	$149,500
				Subtotal, Wood Products:	$799,500
				20% Premium:	$159,900
				Maximum Cost; Low-Emitting Materials, Composite Wood:	**$159,900**
				Minimum Cost; Low-Emitting Materials, Composite Wood:	**$0**

Cost Estimate
Credit EQ5 - Indoor Chemical & Pollutant Source Control

Capital Cost Impact

Assumptions

1. Will require additional design costs
2. Construction premiums include entry mats, copier exhaust, and chemical drains

Maximum Cost

Item	Description	QTY	Unit	Unit Cost	Total Cost
1.	Design Cost: Specifications	2	HR	$100	$200
2.	Design Cost: Mechanical Plans	4	HR	$100	$400
3.	Design Cost: Architectural Plans	4	HR	$100	$400
4.	Entry Mats/Grilles	1	LS	$5,000	$5,000
5.	Exhaust for Copiers	1	LS	$3,000	$3,000
6.	Drains for Chemicals	1	LS	$2,000	$2,000

Maximum Cost; EQ5, Indoor Chemical & Pollutant Source Control: $11,000

Minimum Cost

Item	Description	QTY	Unit	Unit Cost	Total Cost
1.	Design Cost: Incidental	0	HR	$100	$0
2.	Entry Mats/Grilles	1	LS	$800	$800
3.	Exhaust for Copiers	1	LS	$500	$500
4.	Drains for Chemicals (incidental)	1	LS	$0	$0

Maximum Cost; EQ5, Indoor Chemical & Pollutant Source Control: $1,300

Cost Estimate

Credit EQ6.1 - Controllability of Systems, Lighting

Capital Cost Impact

Assumptions

1. For minimum cost impact, assume occupational sensor switches are included in standard design

Item	Description	QTY	Unit	Unit Cost	Total Cost
1.	Sharp Cut-Off Luminaries	24	EA	$800	$19,200
				Subtotal:	**$19,200**
	Minus Standard Cobra Head Luminary (1/2 price of Sharp Cut-Offs):				**-$9,600**
					$9,600

Round up to nearest thousand to develop maximum cost impact

Maximum Cost Impact; Controllability of Systems, Lighting: **$10,000**

Mainmum Cost Impact; Controllability of Systems, Lighting: **$0**

Cost Estimate

Credit ID1.1 - (SS5.1) Restore 75% of Site

Capital Cost Impact

Assumptions

1. Use cost figures from SS5.1, namely: $3,000 per acre of restoration
2. Subtract cost to achieve SS5.1
3. 75% of total site = .75*25 AC = 18.75 AC

Item	Description	QTY	Unit	Unit Cost	Total Cost
1.	Site Restoration, Adaptive Vegetation	18.75	AC	$3,000	$56,250
				Subtotal; Restore 75% of Site:	$56,000
				Minus Cost to Achieve SS5.1:	-$37,500
				Subtotal; ID1.1, Restore 75% of Site:	$18,500

For maximum/minimum cost scenarios, round down to nearest thousand for minimum cost, and add $3k for maximum cost scenario.

Maximum Cost; Restore 75% of Site: **$18,000**

Minimum Cost; Restore 75% of Site: **$21,000**

Cost Estimate
Credit ID 1.3 - Heat Island Effect, Non-Roof

Capital Cost Impact

Assumptions

1. Credit can be achieved through converting 4160 SY of asphalt paving to concrete paving, and using "white" concrete for all the concrete hardstand. This will make 100% of the total hardsurfaces reflective concrete.
2. Although open grid pavement could meet the requirements of this credit, it is not considered as a viable option inasmuch as the soils in Sisseton are expansive and have low-permeability.
3. To meet this credit with shade tree plantings, approximately 2000 lineal feet of trees would be required. Furthermore, they would need to provide 20' of shade (each) within five years - not likely.

Maximum Cost

Item	Description	QTY	Unit	Unit Cost	Total Cost
1.	Cost of Concrete Paving	4160	SY	$24	$99,840
2.	Minus Cost of Asphalt Paving	4160	SY	-$12.20	-$50,752
3.	Additional Cost for White Concrete	3170	CY	$75.00	$237,750

Total Cost, ID 1.3; Heat Island Effect, Non-Roof: $286,800

Minimum Cost

1.	Assume 15% discount on "maximum" cost scenario	$243,780
2.	Rounded to Nearest Ten Thousand	$240,000

Minimum Cost, ID 1.3; Heat Island Effect, Non-Roof: $240,000

Cost Estimate

Administrative Costs - LEED Review Process

Assumptions

1. Considering A/E hours, not incidental to the design contract (e.g. LEED strategies & research, correspondence, etc.)
2. For every hour of professional administrative time, 1/2 hour of clerical work is required.
3. Add an additional 40% for profit & overhead expenses
4. LEED Registration Fee ($600) & Certification Fee ($5,100 = $0.045/GSF X 100,000 GSF) are included in the estimate.
5. In the process of designing a facility for LEED compliance, the A/E would provide a study, similar to a VE study. This study is considered a part of the administrative costs (listed below.)

Item	Description	QTY	Unit	Unit Cost	Total Cost
1.	A/E Professional Services	360	HR	$75	$27,000
2.	A/E Clerical Services	180	HR	$25	$4,500
				Subtotal:	$31,500
				+ Profit & Overhead Expenses @40%:	$12,600
				LEED Registration & Certification Fee:	$5,700
				Total Cost, Administrative Costs; LEED Review Process:	**$49,800**
				Maximum Cost:	**$45,000**
				Minimum Cost:	**$55,000**

Appendix C:
Detailed Life Cycle Cost Estimates for LEED Credits

Estimates Contained in this Appendix

Cost Estimate
Credit SS3 - Brownfield Redevelopment

Life Cycle Cost Cost Impact

Assumptions

1. Groundwater sampling required annually.
2. On-site treatment will require annual "overturning" of windrows
3. On-site treatment will also require reseeding annually.
4. Administrative burden added as an annual expense.
5. Life Cycle 20 years
6. Discount/Interest Rate 5%

Calculations

			Type (P,F,A)	Present Worth
1. ***Groundwater Sampling***				
Groundwater Extraction	$500.00	per year		
Laboratory Analysis	$2,500.00	per year		
Total, Groundwater Sampling & Analysis:	$3,000.00		A	$37,387
Present Worth, Groundwater Sampling & Analysis:				**$37,387**
2. ***Landfarming***				
Bulldozer Rental	$2,000.00	per year		
Operator	$2,500.00	per year		
Hydroseeding	$1,500.00	per year		
Total, Landfarming:	$6,000.00		A	$74,773
Present Worth, Landfarming:				**$74,773**
3. ***Administrative Burden***				
Administrative Hours	$2,500.00	per year	A	$31,156
Present Worth, Administrative Burden:				**$31,156**

Total Life Cycle Cost, Brownfield Redevelopment* $143,315

* As a minimum Life Cycle Cost Scenario, we assume that offsite remediation and total replacement of soil will require no life cycle costs.

Cost Estimate

Credit SS4.3 - Alternative Transportation: Alternative Fuel Vehicles (AFV)

Life Cycle Cost Cost Impact

Assumptions

1. Assume Hybrid Vehicle Use		
2. Fuel Savings	25%	
3. Average Miles/vehicle/year	15,000	
4. Fuel Cost	$2.25	per gallon
5. Fuel Cost Escalation	8%	per yr (linear)
6. Life Cycle	20	years
7. Average MPG (existing)	25	miles/gallon
8. Discount/Interest Rate	5%	

Calculations

1. *Annual Fuel Cost per Vehicle (A')*

$$\boxed{A' = \frac{[mileage] \times [price / gallon]}{[miles / gallon]}}$$

[mileage] =	5,000	miles/vehicle-yr
[price/gallon] =	$3.00	per gallon
[miles/gallon] =	25	miles/gallon

A' = $600.00 per vehicle per year

2. *Initial (Year 1) Savings (A)*

$$\boxed{A = [fuel\_savings] \times [A']}$$

[fuel_savings] =	25%	
A' =	$600.00	per vehicle per year

A = $150.00 per vehicle per year

3. *Savings due to Uniform Cost Escalation (G)*

$$\boxed{G = [fuel\_cost\_escalation\_rate] \times [A]}$$

[fuel_cost_escalation_rate] =	8%	per yr (linear)
A =	$150.00	per vehicle per year

G = $12.00 per vehicle per year

4. *Life Cycle Cost Savings per Vehicle (P)*

$$\boxed{P = A \times \left(\frac{P}{A}, i, n \right) + G \times \left(\frac{P}{G}, i, n \right)}$$

(P/A,i,n)=	12.4622	(Discount Factor for Annualized Savings with i = 5%, n = 20)
(P/G,i,n)=	98.4884	(Discount Factor for Uniform Gradient with i = 5%, n = 20)
A =	$150.00	per vehicle per year
G =	$12.00	per vehicle per year

P = $3,100 (savings per vehicle over 20-yr life cycle)

Times # of Vehicles: 6

$18,600 Total Estimated LCC Savings, all vehicles

Cost Estimate
Credit SS6.1 - Stormwater Design (Quantity Control)

Life Cycle Cost Cost Impact

Assumptions

1. Pump Maintenance annually, Replace Pump & Controls @ 20 years
2. Clean tank biannually
3. weed control in detention pond annually
4. refurbish manholes once per 10 years
5. Refurbish stormwater detention pond every 10 years
6. Life Cycle 20 years
7. Discount/Interest Rate 5%

Calculations

			Type (P,F,A)	Present Worth
1. ***Stormwater Pump System***				
Pump O&M				
Annual Maintenance	$500.00	per year		
Power Consumption	$150.00	per year		
Total, Pump O&M:	$650.00		A	$8,100
Replace Pump & Controls @ 20 years				
Pump & Controls Replacement	$5,000.00	@ year 20	F	$1,884
		Total, Stormwater Pump System		**$9,985**
2. ***Tank Cleaning***				
Clean Tank Biannually	$1,000.00	per 2 yrs	A	$7,027
		Total, Tank Cleaning		**$7,027**
3. ***Weed Control***				
Annual Weed Control	$1,000.00	per year	A	$12,462
		Total, Weed Control		**$12,462**
4. ***Refurbish Manholes***				
Manhole Repair/Refinishing	$3,500.00	per 10 yrs	F	$3,468
		Total, Refurbish Manholes		**$3,468**
5. ***Refurbish Stormwater Detention Pond***				
Regrade Stormwater Pond	$8,500.00	per 10 yrs	A	$16,949
		Total, Refurbish Stormwater Detention Pond		**$16,949**
		Total Life Cycle Cost, Stormwater Quantity Control*		**$49,900**

* Because these systems were implemented in the baseline case, the actual life cycle cost is $0

Cost Estimate
Credit SS6.2 - Stormwater Design (Quality Control)

Life Cycle Cost Cost Impact

Assumptions

1. weed control in detention pond annually
2. refurbish manholes once per 10 years
3. Refurbish stormwater retention pond every 10 years
4. Life Cycle 20 years
5. Discount/Interest Rate 5%

Calculations

			Type (P,F,A)	Present Worth
1. ***Weed Control***				
Annual Weed Control	$1,000.00	per year	A	$12,462
		Total, Weed Control		**$12,462**
2. ***Refurbish Manholes***				
Manhole Repair/Refinishing	$3,500.00	per 10 yrs	F	$3,468
		Total, Refurbish Manholes		**$3,468**
3. ***Refurbish Stormwater Detention Pond***				
Regrade Stormwater Pond	$12,000.00	per 10 yrs	F	$11,890
		Total, Refurbish Stormwater Detention Pond		**$11,890**
		Total Life Cycle Cost, Stormwater Quantity Control		**$27,800**

Cost Estimate
Credit SS7.1 - Heat Island Effect, Non-Roof

Life Cycle Cost Cost Impact

<u>Assumptions</u>

1. No life cycle costs will be incurred as a result of SS1
2. Life Cycle 20 years
3. Discount/Interest Rate 5%

<u>Calculations</u>

			Type (P,F,A)	Present Worth
Savings: No pavement replacement @ 20 years	-$25,000.00	@ year 20	F	-$9,422

Total Life Cycle Cost, Heat Island Effect, Non-Roof: -$9,422

Assume the cost to range from +25% to -25%

Minimum Cost: **-$11,800**
Maximum Cost: **-$7,100**

Cost Estimate
Credit SS7.2 - Heat Island Effect, Roof

Life Cycle Cost Impact

<u>Assumptions</u>

1. PVC Roof Meets Requirements
2. PVC Roof has same service life as EPDM roof
3. Energy Savings (high albedo) result in $1,500 annual savings
4. Life Cycle 20 years
5. Discount/Interest Rate 5%

<u>Calculations</u>

			Type (P,F,A)	Present Worth
1. Replacement Cost, PVC Roof (Difference compared with EPDM roof)	$30,000	at 20 yrs	F	$11,307
2. Energy Savings	-$1,500	per year	A	-$18,693

Total Life Cycle Cost, Credit WE1.1: -$7,387

Assume a 25% variance (+/-) for maximum and minimum LCC costs/savings

LCC Savings (Low) = **-$5,500**
LCC Savings (High) = **-$9,200**

Cost Estimate

Credit WE1.1 - Water Efficienct Landscaping (Reduce Potable Use by 50%)

Life Cycle Cost Impact

Assumptions

1. Replace DRIP System once every 10 years
2. Specialized Maintenance needed every 2 years
3. Routine maintenance applied every year.
4. Life Cycle 20 years
5. Discount/Interest Rate 5%
6. Water Savings = 85,000/month * 4 months/yr = 340,000 gallons/year
7. Water Cost = $25 per 10,000 gallons

Calculations

			Type (P,F,A)	Present Worth
1. Replace Drip System	$10,000	per 10 yrs	F	$9,908
2. Specialized Maintenance	$1,500	per 2 yrs	A	$9,217
3. Routine Maintenance	$1,000	per year	A	$12,462
4. Water Savings	-$853	per year	A	-$10,627
		Total Life Cycle Cost, Credit WE1.1:		**$20,960**

Minimum Scenario

Assume routing maintenance and replacement costs are identical to conventional system

Only item 2) would apply in this case, i.e. Specialized Maintenance

Minimum Cost: **$9,217**

Cost Estimate

Credit WE1.2 - Irrigation Efficiency (No Potable Use or No Irrigation)

Life Cycle Cost Impact

Assumptions

1. Replace DRIP System once every 10 years				
2. Specialized Maintenance needed every 2 years				
3. Routine maintenance applied every year.				
4. Life Cycle	20 years			
5. Discount/Interest Rate	5%			
6. Water Savings = 175,000 gal/mo * 4 mos/yr =			700,000	gallons/year
7. Water Cost =	$25	per	10,000	gallons

Calculations

			Type (P,F,A)	Present Worth
1. Replace Drip System	$10,000	per 10 yrs	F	$9,908
2. Specialized Maintenance	$1,500	per 2 yrs	A	$9,217
3. Routine Maintenance, DRIP System	$1,000	per year	A	$12,462
4. Potable Water Savings	-$1,756	per year	A	-$21,879
5. Pump O&M	$1,500	per year	A	$18,693
6. Replace Pump System	$15,000	per 10 yrs	F	$14,862
7. Tank Maintenance	$5,000	per 10 yrs	F	$4,954
Total Life Cycle Cost, Credit WE1.1:				**$48,218**

As a minimum cost, xeriscaping is assumed to require the same degree of maintenance as turfgrass (in this case, weeding in lieu of mowing.) Hence, a life cycle cost impact of -$21,879 (water savings.)

Cost Estimate

Credit WE2 - Innovative Wastewater Technologies

Life Cycle Cost Impact

Assumptions

1. Waterless Urinals save 220 gallons/day (55,000 gal/yr)
2. Waterless Urinals save on flush valve maintenance
3. Specialized Training needed for waterless urinals
4. Low Flow Water Closets also save 220 gallons/day (55,000 gal/yr)
5. Maintenance on low-flow water closets is no different than existing maint.
6. Rainwater Collection System will require maintenance
7. Rainwater Pump & Controls will cost a premium
8. Life Cycle 20 years
9. Discount/Interest Rate 5%
10. Water Savings = 440gal/day * 250 days/yr = 110,000 gallons/yea
11. Water Cost = $25 per 10,000 gallons

Calculations

				Type (P,F,A)	Present Worth
1.	Potable Water Savings	-$276	per yr	A	-$3,438
2.	Flush Valve Savings	-$350	per yr	A	-$4,362
	Specialized Training:				
3.	Waterless Urinals	$1,000	per 5 yrs	A	$2,255
4.	Pump O&M	$1,500	per year	A	$18,693
5.	Replace Pump System	$15,000	per 10 yrs	F	$14,862
6.	Rainwater Treatment O&M	$2,500	per year	A	$31,156
7.	Tank Maintenance	$5,000	per 10 yrs	F	$4,954

Total Life Cycle Cost, Credit WE1.1: $64,120

For the same reasons cited on the Capital Cost impact, the cost range will be developed by using the estimated cost as the average between the two extremes, and calculate them as +/- 10% of the average, and rounding them to the nearest $1,000.

Maximum LCC Cost: $71,000
Minimum LCC Cost: $58,000

Cost Estimate

Credit EA1 - Optimize Energy Performance

Life Cycle Cost Cost Impact

<u>Assumptions</u>

1. Assume maintenance of Ground Source Heat Pump is same as conventional HVAC
2. LCC impacts/savings calculated with a +/- 15% range
3. Life Cycle 20 years
4. Discount/Interest Rate 5%
5. Assume baseline energy use of 24.8 kWh/ft^2/yr (ASHRAE 90.1)

<u>Calculations</u>

Energy Use Rate (baseline) =	24.8	kWh/ft^2/yr
Facility Size =	<u>84,895</u>	ft^2
Baseline kWh (ASHRAE 90.1) =	2,106,923	kWh/yr
Assumed Cost/kWh =	$0.026	(See Note 1 Below)

Annual Savings Estimated for LEED EA1 Benchmarks:

			Present Worth			**Adjusted[2]**	
Benchmarks	**% Savings**	**in $'s**	**base**	**min**	**max**	**min**	**max**
First Two Points	14.0%	$7,699	$95,943	$81,551	$110,334	$0	$0
Points 3-5	24.5%	$5,774	$71,957	$61,164	$82,751	$61,164	$82,751
Points 6-7	31.5%	$3,849	$47,971	$40,776	$55,167	$40,776	$55,167
Points 8-10	42.0%	$5,774	$71,957	$61,164	$82,751	$61,164	$82,751

<u>Notes</u>

1. The cost of energy (per kWh) is assumed to remain fixed over the 20-year life cycle. This will ensure an extremely conservative estimate of energy savings.
2. Present Worth values are adjusted by subtracting the min and max values for the first two points, since these are considered to be the true baseline case, i.e. standard practice within IHS

Cost Estimate
Credit EA2 - On-Site Renewable Energy

Life Cycle Cost Cost Impact

Assumptions

1. Photovoltaic Cells would need replacement @ 30 years (beyond this analysis)
2. Periodic Maintenance (cleaning, repair) would cost roughly $500/year
3. LCC impacts/savings calculated with a +/- 15% range
4. Life Cycle 20 years
5. Discount/Interest Rate 5%

Calculations

			Type (P,F,A)	Present Worth
1. ***Periodic Maintenance***				
Repair/Replace Parts	$500.00	per year	A	$6,231
3. ***Energy Savings***				
Energy Savings	-$3,563.00	per year	A	-$44,403
	Total, On-Site Renewable Energy :			**-$38,172**

Total Life Cycle Cost, On-Site Renewable Energy: **-$43,900** min
-$32,400 max

Cost Estimate

Credit EA4 - Enhanced Refrigerant Management

Life Cycle Cost Cost Impact

<u>Assumptions</u>

1. Fluid will not need to be replaced over life cycle
2. 20-year replacement of chillers
3. Chiller type will cost $20k above standard chiller
4. Life Cycle 20 years
5. Discount/Interest Rate 5%

<u>Calculations</u>

		Type (P,F,A)	Present Worth
1. ***Chiller Replacement***			
Replace Chillers	$20,000.00 @ 20 yrs	F	$7,538
	Total, Rrplace Chillers:		**$7,538**

Total Life Cycle Cost, Enhanced Refrigerant Management: $7,500

Assume a 25% smaller cost for minimum LCC cost ($5,600)

Cost Estimate

Credit EA5 - Measurement and Verification

Life Cycle Cost Cost Impact

Assumptions

1. Meters will be automated, requiring no additional man hours for reporting
2. Replacement of failed components/repair will cost 10% of capital cost every year.
3. Life Cycle 20 years
4. Discount/Interest Rate 5%

Calculations

				Type (P,F,A)	Present Worth	
	1. ***Maintenance of Extra Meters***					
max:	Replace/Repair Meters	$1,200.00	per year	A	$14,955	
min:	Replace/Repair Meters	$300.00	per year	A	$3,739	
		Total, Maintenance of Extra Meters:			**$14,955**	max
					$3,739	min

Total Life Cycle Cost, Enhanced Refrigerant Management: **$15,000** max
$3,700 min

Cost Estimate
Credit MRPR1 - Storage & Collection of Recyclables

Life Cycle Cost Cost Impact

Assumptions

1. Recycling Program will require 0-5 man-hours per week @ $20/hr
2. Refurbish recycling center @ 20 years
3. Life Cycle 20 years
4. Discount/Interest Rate 5%

Calculations

			Type (P,F,A)	Present Worth
1. ***Recycling Program***				
Weekly Maintenance	$100.00	per week		
x (weeks/yr)	52	per year		
Total, Annual Maintenance:	$5,200.00		A	$64,803
		Total, Recycling Program		**$64,803**
2. ***Refurbish Recycling Center***				
Refurbish Center	$15,000.00	@ 20 yrs	F	$5,653
		Total, Refurbish Recycling Room		**$5,653**

Total Life Cycle Cost, Storage & Collection of Recyclables* **$70,500**

* The minimum life cycle cost is $5,653, because the labor attributable to this effort could be considered as incidental work done by full-time staff.

Cost Estimate

Credit EQ1 - Outdoor Air Delivery Monitoring

Life Cycle Cost Cost Impact

Assumptions

1. Replacement of Carbon Monoxide Detector @ 20 years
2. CO_2 Detector will cost the same at 20 years as Capital Cost (+/- 25%)
3. Life Cycle 20 years
4. Discount/Interest Rate 5%

Calculations

			Type (P,F,A)	Present Worth	
	1. ***Replace CO Detector***				
max:	Replace CO_2 Detector	$3,250.00 @ 20 yrs	F	$1,225	
min:	Replace CO_2 Detector	$1,950.00 @ 20 yrs	F	$735	
		Total, Replace CO Monitors:		**$1,225**	max
				$735	min
		Total Life Cycle Cost, Outdoor Air Delivery Monitoring:		**$1,200**	max
				$700	min

Cost Estimate
Credit EQ2 - Increased Ventilation

Life Cycle Cost Cost Impact

Assumptions

1. Continual Cost from additional venting/heating/cooling
2. Cost estimated to be 3-10% of normal heating & cooling bill
3. Life Cycle 20 years
4. Discount/Interest Rate 5%

Calculations

				Type (P,F,A)	Present Worth	
	1. ***Additional HVAC Operation***					
min:	Additional HVAC Operation	$1,149.08	per year	A	$14,320	
max:	Additional HVAC Operation	$3,830.27	per year	A	$47,734	
		Total, Additional HVAC Operation:			**$14,320**	min
					$47,734	max
	Total Life Cycle Cost, Outdoor Air Delivery Monitoring:				**$14,300**	min
					$47,700	max

Baseline Energy Cost Estimate - Sisseton

Energy Type	Qty	Unit	Cost/Unit	Cost
Electricity	373,460	kWH	$0.0598	$22,333
Fuel Oil	1,715	GAL	$0.6700	$1,149
Propane	13,830	CF	$0.6340	$8,768
			Total Cost:	$32,250
			GSF (existing facility):	32,166
			Cost/GSF:	**$1.00**
			GSF (new facility):	84,895
			Baseline Energy Cost:	**$85,117**
			% for Heating/Cooling:	45%
			Annual Heating/Cooling Cost:	**$38,303**

Cost Estimate
Credit EQ5 - Indoor Chemical & Pollutant Source Control

Life Cycle Cost Cost Impact

Assumptions

1. Entry way assumed to have $0 life cycle cost
2. High efficiency filters will have a continual cost of $100-$200/year
3. Life Cycle 20 years
4. Discount/Interest Rate 5%

Calculations

				Type (P,F,A)	Present Worth	
	1. ***High Efficiency Filters***					
max:	Operate High Eff. Filters	$200.00	per year	A	$2,492	
min:	Operate High Eff. Filters	$100.00	per year	A	$1,246	
	Total, Operate High Efficiency Filters:				**$2,492**	max
					$1,246	min
	Total Life Cycle Cost, Indoor Chemical & Pollutant Source Control:				**$2,500**	max
					$1,200	min

Cost Estimate
Credit EQ7.2 - Thermal Comfort, Verification

Life Cycle Cost Cost Impact

Assumptions

1. Comfort Survey will not be amortized to present value

Calculations

	Quantity			Unit	Total Cost	
Description	**Min**	**Max**	**Unit**	**Cost**	**Min**	**Max**
1. Comfort Survey	1,000	2,000	LS	$1	$1,000	$2,000
					$1,000	$2,000

Maximum Life Cycle Cost; Thermal Comfort, Verification: **$2,000**

Minimum Life Cycle Cost; Thermal Comfort, Verification: **$1,000**

Cost Estimate

Credit ID 1.3 - 100% Hardscape Meets Requirements

Life Cycle Cost Cost Impact

Assumptions

1. No life cycle costs will be incurred as a result of SS1
2. Life Cycle 20 years
3. Discount/Interest Rate 5%

Calculations

			Type (P,F,A)	Present Worth
Savings: No pavement replacement @ 20 years	-$25,000.00	@ year 20	F	-$9,422

Total Life Cycle Cost, 100% Hardscape Meets Requirements: -$9,422

Assume the cost to range from +25% to -25%

Minimum Cost:	**-$11,800**
Maximum Cost:	**-$7,100**

The projected savings are identical to LCC savings for SS7.1, because this credit would double the amount of hardscape not needing replacement

Appendix D:
Selected Design Scenarios and Calculations

Design Summaries and Calculations Contained in this Appendix

Site Selection

Water Efficiency

Energy & Atmosphere

Design Calculations

Credit SS3 - Brownfield Redevelopment

<u>Assumptions</u>

Plume Dimensions (maximum cost scenario)

1. Assume that plume has an ellipsoidal shape
2. Dimemsions for the three plume diameters are:

r_1 =	25 ft (max)	15 ft (min)
r_2 =	50 ft (max)	30 ft (min)
r_3 =	25 ft (max)	15 ft (min)

<u>Calculations</u>

Plume Volume, Maximum Cost Scenario

$\mathbf{V_{plume}}$ **= 5000 CY**

Plume Volume, Minimum Cost Scenario

$\mathbf{V_{plume}}$ **= 1000 CY**

Design Calculations

Credit SS6.1 - Stormwater Design (Quantity Control)

Case 1: Baseline Case (Using 6-month, 24-hr storm)

Given

A (open) =	478,000	SF	
I =	0.65		(Percent of Impervious Area)
A (impv) =	735,000	SF	
A (tot) =	1,213,000	SF	

Assumptions

P =	1.5	inches	(six-month, 24-hour storm, estimated @ 75% of 1-yr, 24-hr storm)
t_c =	20	minutes	(concentration time)

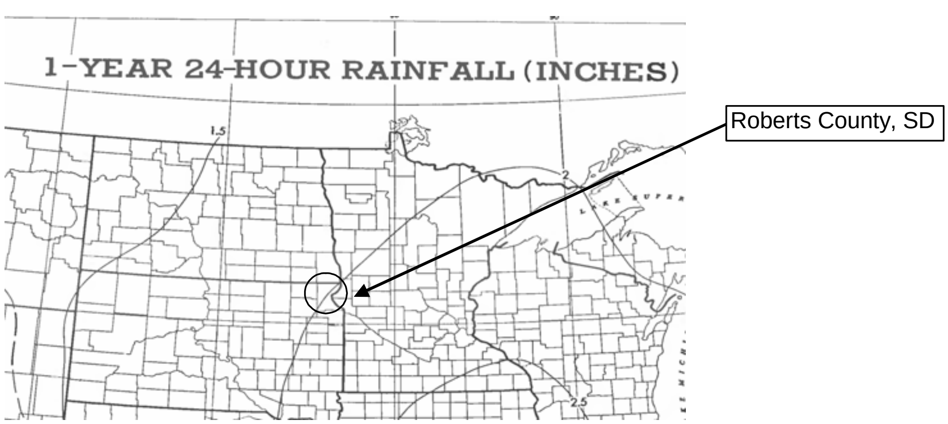
Calculations

	Design Case	Predevel-opment Case	Required Detention		
R_v =	0.64	0.05			(Volumetric Runoff Coefficient)
Q_a =	0.9525	0.075			(Runoff Volume in watershed inches)
WQ_v =	**96,300**	**7,600**	**88,700**	CF	(Total Volume of Runoff)
CN =	94	69			(Curve Number)
I_a =	0.123	0.885			(Initial Abstraction)
I_a/P =	0.082	0.590			(Initial Abstraction per inch of Precipitation)
q_u =	730	200		csm/in	(Unit Peak Discharge)
A =	0.0435	0.0435		mi^2	(runoff area, in square miles)
Q_p =	**30.3**	**0.7**	**29.6**	cfs	(peak runoff rate)

Required Detention Pond Parameters

A_s =	11,088	SF	(Surface Area, assuming an average depth of 8')
L_s =	105	LF	(Average Linear Dimension of a Rectangular Pond)

Isopluvial Map for Northern Plains (NOAA)



Required Excavation

Assume required detention + 20%

$\mathbf{V_{exc}}$ **=**	106440	CF	
=	3942.222	CY	
	4000	**CY**	(Rounded)

Design Calculations

Credit SS6.1 - Stormwater Design (Quantity Control)
Case 2: Design Case (Using 2-year, 24-hr storm)

Given

A (open) =	478,000	SF	
I =	0.65		(Percent of Impervious Area)
A (impv) =	735,000	SF	
A (tot) =	1,213,000	SF	

Equations

$$R_v = .05 + .9 \times I$$

$$Q_a = P \times R_v$$

$$WQ_v = P \times R_v \times A$$

$$CN = \left[\frac{1000}{10 + 5P + 10Q_a - 10\sqrt{Q_a^2 + 1.25Q_aP}}\right]$$

$$I_a = \left(\frac{200}{CN}\right) - 2$$

Assumptions

P =	2.5	inches	(two-year, 24-hour storm)
t_c =	20	minutes	(concentration time)

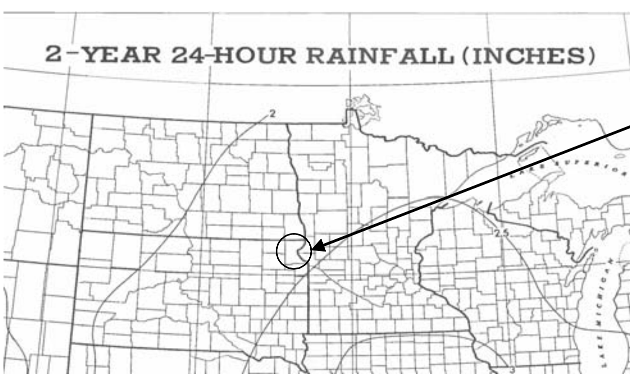
Calculations

	Design Case	Predevel-opment Case	Required Detention		
R_v =	0.64	0.05			(Volumetric Runoff Coefficient)
Q_a =	1.5875	0.125			(Runoff Volume in watershed inches)
WQ_v =	**160,500**	**12,600**	**147,900**	CF	(Total Volume of Runoff)
CN =	91	58			(Curve Number)
I_a =	0.205	1.475			(Initial Abstraction)
I_a/P =	0.082	0.590			(Initial Abstraction per inch of Precipitation)
q_u =	730	200		csm/in	(Unit Peak Discharge - derived using Unit Peak Discharge nomograph, SCS Method)
A =	0.0435	0.0435		mi^2	(runoff area, in square miles)
Q_p =	**50.4**	**1.1**	**49.3**	cfs	(peak runoff rate)

Required Detention Pond Parameters

A_s =	18,488	SF	(Surface Area, assuming an average depth of 8')
L_s =	136	LF	(Average Linear Dimension of a Rectangular Pond)

Isopluvial Map for Northern Plains (NOAA)



Required Excavation

Assume required detention + 20%

V_{exc} =	177480	CF	
=	6573.333	CY	
	6500	**CY**	(Rounded)

Design Calculations

Credit SS6.2 - Stormwater Design (Quality Control)

Given

Annual Precipitation =	25	inches	
Design Storm =	0.75	inches	
A (open) =	478,000	SF	
I =	0.65		(Percent of Impervious Area)
A (impv) =	735,000	SF	
A (tot) =	1,213,000	SF	
h_{pond} =	5	FT	(Pond Depth)

Assumptions

1. Drainage Swales will infiltrate sufficient to treat 10% of design storm.
2. A Retention Pond will be used to treat stormwater
3. The existing underground storage facility will provide no treatment, only flow control
4. Use a 1.5 factor of safety in designing retention pond
5. Excavation will require 100% in addition to required retention volume.

Calculations

R_v =	0.64		(Volumetric Runoff Coefficient)
Q_a =	0.48		(Runoff Volume in watershed inches)
WQ_v =	43,300	CF	(Total Volume of Runoff to Treat)
V_{pond} =	64,950	CF	(Minimum Required Pond Volume)
V_{exc} =	**4,811**	CY	(Required Excavation for Pond)

Required Detention Pond Parameters

A_s =	16,900	SF	(Surface Area, assuming an average depth of 5')
L_s =	130	LF	(Average Linear Dimension of a Rectangular Pond)
Ls,t =	150	LF	(Average Linear Dimension at top of Pond (fenceline)

<u>Notes about SS6.1 & 6.2</u>

For design purposes, the State of Washington uses a water quality design storm from the runoff predicted from the **6-month, 24-hour** storm. (Volume III, 2-1)

If your project is located in one of the following jurisdictions, you must obtain a federal Stormwater permit from EPA:

- Alaska
- Idaho
- Massachusetts
- New Hampshire
- New Mexico
- Tribal Lands (most, but not all.)

In other jurisdictions, the States and/or municipalities issue the permit.

In most cases, a Construction General Permit (CGP) is the most prudent course of action. The CGP has three main requirements:

1. <u>Develop a Stormwater Pollution Prevention Plan (SWPPP)</u>, including:
    a. Site Description identifying sources of pollution;
    b. A description of how you will prevent erosion, sediment, and other pollutants from contaminating Stormwater;
    c. A description of how you will control Stormwater flow from your site;
    d. Documentation supporting permit eligibility with regard to the Endangered Species Act;
    e. Documentation supporting permit eligibility with regard to local Total Maximum Daily Load (TMDL) requirements;
    f. Clearly outlined roles and responsibilities of different operators; and
    g. The protocol you will use to inspect your site.

2. <u>Submit a Notice of Intent (NOI)</u>
   The EPA will place the project in "Active" status. Note: the NOI is held for seven days prior to EPA placing the project in "Active" status.

3. <u>Submit a Notice of Termination (NOT)</u>
   Applicable when the site has been stabilized, or when the project has changed hands (i.e. different owner, or permit.)

Effective March 2003, EPA Phase II Stormwater regulations require construction sites of **one acre** and larger to apply for an NPDES permit.

Waivers may be applicable for small construction projects (i.e. one to five acres,) if it can be demonstrated that there will be no adverse effects to water quality (e.g. well below allowable TMDL, on-site infiltration, etc.)

SWPPP requirements were designed to allow for maximum flexibility to develop storm water controls based on site specifics (e.g. precipitation patterns, soil type, slopes, sensitivity of receiving waters, etc.) Hence, BMPs may vary significantly.

Estimate of Irrigation Requirement

Sisseton Ambulatory Care Facility

Sisseton, SD

Equations:

$$K_L = k_s \times k_d \times k_{mc}$$

$$ET_L[in] = ET_0[in] \times K_L$$

$$TPWA[gal] = A[SF] \times \frac{ET_L[in]}{IE}$$

Assumptions:

ET_0 = 6 inches

Design Case

Landscape Type	Area [SF]	Species Factor (k_s)		Density Factor (k_d)		Microclimate Factor (k_{mc})		Landscape Coefficient K_L	Landscape Evapotranspiration ET_L	Irrigation Efficiency IE		Total Potable Water Applied TPWA [gal]
Trees	37,000	Low	0.2	Avg	1.0	High	1.4	**0.3**	1.68	None	-	0
Groundcovers	234,000	Low	0.2	Avg	1.0	High	1.2	**0.2**	1.44	None	-	0
Mixed	182,000	Low	0.2	Avg	1.1	High	1.4	**0.3**	1.85	None	-	0
Turfgrass	25,000	Avg	0.7	Avg	1.0	High	1.2	**0.8**	5.04	Drip	0.9	87,262
	478,000										Subtotal [gal]	87,262
											July Rainwater/Graywater Harvest [gal]	0
											Net GPWA [gal]	**87,262**

Baseline Case

Landscape Type	Area [SF]	Species Factor (k_s)		Density Factor (k_d)		Microclimate Factor (k_{mc})		Landscape Coefficient K_L	Landscape Evapotranspiration ET_L	Irrigation Efficiency IE		Total Potable Water Applied TPWA [gal]
Trees	37,000	Low	0.2	Avg	1.0	High	1.4	**0.3**	1.68	None	-	0
Groundcovers	234,000	Low	0.2	Avg	1.0	High	1.2	**0.2**	1.44	None	-	0
Mixed	172,000	Low	0.2	Avg	1.1	High	1.4	**0.3**	1.848	None	-	0
Turfgrass	35,000	Avg	0.7	Avg	1.0	High	1.2	**0.8**	5.04	Sprinkler	0.625	175,920
	478,000										Subtotal [gal]	175,920
											July Rainwater/Graywater Harvest [gal]	0
											Net GPWA [gal]	**175,920**

Net Reduction in Potable Water Use = **50%**

A 50% Reduction can be achieved through decreasing turfgrass by 10,000 SF, and by replacing conventional irrigation(63% efficiency) to a DRIP system (90% Efficiency)

Estimate of Irrigation Requirement
Sisseton Ambulatory Care Facility
Sisseton, SD

Equations:

$$K_L = k_s \times k_d \times k_{mc}$$

$$ET_L[in] = ET_0[in] \times K_L$$

$$TPWA[gal] = A[SF] \times \frac{ET_L[in]}{IE}$$

Assumptions:

ET_0 = 6 inches
P_{Jul} = 2.5 inches
A_{roof} = 85,960 ft^2
V_{tot} = 21,620 LPD
η_{rw} = 0.75 (Rainwater Collection Efficiency)

Design Case

Landscape Type	Area [SF]	Species Factor (k_s)		Density Factor (k_d)		Microclimate Factor (k_{mc})		Landscape Coefficient K_L	Landscape Evapotranspiration ET_L	Irrigation Efficiency IE		Total Potable Water Applied TPWA [gal]
Trees	37,000	Low	0.2	Avg	1.0	High	1.4	**0.3**	1.68	None	-	0
Groundcovers	234,000	Low	0.2	Avg	1.0	High	1.2	**0.2**	1.44	None	-	0
Mixed	182,000	Low	0.2	Avg	1.1	High	1.4	**0.3**	1.85	None	-	0
Turfgrass	10,000	Avg	0.7	Avg	1.0	High	1.2	**0.8**	5.04	Drip	0.9	34,905
	463,000									Subtotal [gal]		34,905
										July Rainwater/Graywater Harvest [gal]		34,905
										Net GPWA [gal]		**0**

Baseline Case

Landscape Type	Area [SF]	Species Factor (k_s)		Density Factor (k_d)		Microclimate Factor (k_{mc})		Landscape Coefficient K_L	Landscape Evapotranspiration ET_L	Irrigation Efficiency IE		Total Potable Water Applied TPWA [gal]
Trees	37,000	Low	0.2	Avg	1.0	High	1.4	**0.3**	1.68	None	-	0
Groundcovers	234,000	Low	0.2	Avg	1.0	High	1.2	**0.2**	1.44	None	-	0
Mixed	172,000	Low	0.2	Avg	1.1	High	1.4	**0.3**	1.848	None	-	0
Turfgrass	35,000	Avg	0.7	Avg	1.0	High	1.2	**0.8**	5.04	Sprinkler	0.625	175,920
	478,000									Subtotal [gal]		175,920
										July Rainwater/Graywater Harvest [gal]		0
										Net GPWA [gal]		**175,920**

Net Reduction in Potable Water Use = **100%**

A 100% Reduction can be achieved through decreasing turfgrass by 25,000 SF, replacing conventional irrigation(63% efficiency) to a DRIP system (90% Efficiency), and harvesting rainwater/graywater at a rate of 35,000 gallons in one month (July, other months will require less harvesting.)

July Rainwater Harvest

$V_{rw,jul}$ = 2.5 inches X 85,960 ft^2 = 100,466 gallons (>34,905)

Graywater Requirement

$V_{gw,req'd}$ = (none)

Thus, this credit can be achieved through a combination of: 1) reduce irrigable landscaping (turfgrass,) 2) utilize DRIP technology to improve efficiency, and 3) harvest rainwater.

Estimate of Wastewater Generation
Sisseton Ambulatory Care Facility
Sisseton, SD

Assumptions:

Total Staff =	188
Annual OPVs =	49,540
Number of Days Open =	250
Daily OPVs =	198
Total Occupants =	386
(Male FTEs) =	**94**
(Female FTEs) =	**94**
(Male Patients) =	**99**
(Female Patients) =	**99**

Given:

Annual Precip =	22	inches
Roof Area =	85,960	SF
η_{rw} =	0.75	(Rainwater Collection Efficiency)
SSER Estimate =	44,410	LPD
=	11,733	GPD
=	2,933,289	GPY

Design Case

Fixture Type	Daily Uses	Flow Rate [GPF]	Occupants	Sewage Generation [gal]
Low-Flow Water Closet (Male FTE)	1	1.1	94	103
Low-Flow Water Closet (Male Patient)	0.1	1.1	99	11
Low-Flow Water Closet (Female FTE)	3	1.1	94	310
Low-Flow Water Closet (Female Patient)	0.5	1.1	99	54
Waterless Urinal (male FTE)	2	0.0	94	0
Waterless Urinal (male Patient)	0.4	0.0	99	0

Total Daily Volume [gal]	479
Annual Work Days	250
Annual Volume [gal]	119,735
Rainwater Volume Available [gal]	884,099
Rainwater or Graywater Reuse Volume [gal]	10,000
TOTAL ANNUAL VOLUME [gal]	109,735

Baseline Case

Fixture Type	Daily Uses	Flow Rate [GPF]	Occupants	Sewage Generation [gal]
Water Closet (Male FTE)	1	1.6	94	150
Water Closet (Male Patient)	0.1	1.6	99	16
Water Closet (Female FTE)	3	1.6	94	451
Water Closet (Female Patient)	0.5	1.6	99	79
Urinal (male FTE)	2	1.0	94	188
Urinal (male Patient)	0.4	1.0	99	40

Total Daily Volume [gal]	924
Annual Work Days	250
TOTAL ANNUAL VOLUME [gal]	231,060

Net Reduction in Potable Water Use = 53%

(Without Rainwater Reuse) = 48%

Excerpts from Sisseton Ground Source Heat Pump Energy Study

Replacement Facility
SISSETON HEALTH CENTER

Sisseton, South Dakota
IHS Project Number: HHSI10200006
Leo A Daly Project No: 001-00502-005

LEED Energy Study

16 December 2005

LEO A DALY

PLANNING
ARCHITECTURE
ENGINEERING
INTERIORS

EST. 1915

ATLANTA
AUSTIN
DALLAS
FORT WORTH
HONG KONG
HONOLULU
HOUSTON
LAS VEGAS
LOS ANGELES
MIAMI
MINNEAPOLIS
OMAHA
PHOENIX
SAN ANTONIO
WACO
WASHINGTON DC

Replacement Health Center
LEED-NC v2.1 EAc1

A. Project Narrative:

The new Replacement Health Center in Sisseton, SD performs 32% better than ASHRAE 90.1-1999 requirements using the LEED Energy Cost Budget methodology. This earns 4 LEED points.

The Replacement Health Center is an 85,000-SF, single-story building that will serve the Sisseton-Wahpeton Sioux tribe. Geothermal heat pumps provide heating and cooling for the entire facility. Ventilation air is provided by a central air-handling unit that treats fresh air first with an plate and frame heat exchanger, then passes the air through a glycol coil (served by water source geothermal water-to-water heat pumps) to further temper the air. Ventilation air is ducted to all the water source geothermal water-to-air heat pumps located throughout the building.

This system was compared to ASHRAE Standard 90.1-1999 using the Energy Cost Budget Method outlined in section 11 of the referenced standard. According to ASHRAE 90.1-1999, the comparison system should be modeled as a water-source heat pump system served by a cooling tower and fossil fuel boiler. The standard outlines specific equipment efficiencies to be used, see Part C, Comparison of Budget Design versus Design Energy Case for more information.

Both the budget and design energy cases were modeled in Carrier's Hourly Analysis Program (HAP) version 4.2a, which calculates the heating and cooling loads and the building energy usage for each hour of the year.

The energy rates used for both the budget and as-designed cases were based on the local utility rates applicable at the time of the project design. The rates include the Otter Tail Power Company Interruptible 170 commercial rate for electricity and the Dakota Sioux Propane commercial rate for propane fuel.

The analysis was based on U.S. climatic data for Huron, SD (Table D-1 of ASHRAE 90.1-1999), and the building envelope requirements prescribed in Table B-19 of ASHRAE 90.1-1999. The TMY2 weather file for Huron, SD was used for the analysis. This is the closest weather station to the project site for which detailed weather data is available.

B. Building Energy Efficiency Measures:

1. Additional Insulation:
   The as-designed U-value for steel frame walls in this building is 0.260 W/m^2K versus 0.477 W/m^2K allowed by ASHRAE 90.1-1999. This is accomplished by adding 50 mm of rigid insulation between the face brick and the steel framing. The as-designed U-value for the roof in this building is 0.248 W/m^2K versus 0.358 W/m^2K allowed by ASHRAE 90.1-1999. This is accomplished by adding 75 mm of rigid insulation in addition to the standard 75 mm.

2. High efficiency glazing:
   The assembly U-value for the as-designed fenestration is 1.931 W/m^{2}K versus 3.236 W/m^{2}K allowed by ASHRAE 90.1-1999.

3. High efficiency water source geothermal heat pumps:
   The design energy case HVAC system consists of a water source geothermal water source heat pump system versus a water-source heat pump system (with a cooling tower and propane boiler). See Part C, Comparison of Budget Design versus Design Energy Case for equipment efficiencies.

C. Comparison of Budget Design versus Design Energy Case:

	Building Design **(Design Energy Cost Case)**	**ASHRAE 90.1-1999 Prescriptive Requirements (Energy Cost Budget Case)**
Building Envelope		
Wall Construction	Steel Frame: U-value = 0.260 W/m^{2}K	Steel Frame: U-value = 0.477 W/m^{2}K
Opaque Doors	Swinging: Entry Door: U-value = 5.451 W/m^{2}K Insulated Metal Door: U-value = 1.987 W/m^{2}K Non-Swinging: Insulated Metal Garage Door: U-value = 1.363 W/m^{2}K	Swinging: U-value = 3.975 W/m^{2}K Non-swinging: U-value = 2.839 W/m^{2}K
Windows	• 28% window-to-wall ratio • Metal Frame, Double-Pane low-e glass • U-value = 1.931 W/m^{2}K • SHGC = 0.37	• 28% window-to-wall ratio • U-value = 3.236 W/m^{2}K • SHGC = 0.39 • SHGC = 0.49 (north)
Floor	• Concrete Slab-on-Grade w/ perimeter insulation • Slab: F-value = 4.145 W/m^{2}K • Insulation: U-value = 5.678 W/m^{2}K	• Uninsulated concrete Slab-on-Grade • Slab: F-value = 4.145 W/m^{2}K • No perimeter insulation
Roof	• R-23 built-up roof • U-value = 0.248 W/m^{2}K	• R-15 built-up roof • U-value = 0.358 W/m^{2}K

	Building Design (Design Energy Cost Case)	ASHRAE 90.1-1999 Prescriptive Requirements (Energy Cost Budget Case)
Electrical Systems		
Lighting Power Density (See Note a)	Average Lighting Density by Space (W/m^2) • Enclosed Office = 18.837 • Open Office = 17.976 • Conference = 17.868 • Lobby = 17.976 • Lounge = 12.594 • Restrooms = 20.990 • Corridor = 13.778 • Active Storage = 18.299 • Inactive Storage = 11.840 • Elec/Mech = 14.424 • Nurse Station = 26.587 • Exam/Treatment = 17.653 • Pharmacy = 23.896 • Medical Supply = 19.913 • Physical Therapy = 13.993 • Laundry/HK = 13.240	Average Lighting Density by Space (W/m^2) • Enclosed Office = 16.146 • Open Office = 13.993 • Conference = 16.146 • Lobby = 19.375 • Lounge = 15.069 • Restrooms = 10.764 • Corridor = 17.222 • Active Storage = 31.215 • Inactive Storage = 3.229 • Elec/Mech = 13.993 • Nurse Station = 19.375 • Exam/Treatment = 17.222 • Pharmacy = 24.757 • Medical Supply = 32.292 • Physical Therapy = 20.451 • Laundry/HK = 7.535
Lighting Occupant Sensor Controls	• Occupant sensor controls in private offices and restrooms	• Occupant sensor controls in private offices and restrooms
Equipment Power Density (See Note b)	• Office/Exam = 2.691 W/m^2	• Office/Exam = 2.691 W/m^2
Exterior Lighting (See Note b)	• Exterior Bldg. Lighting = 1kW • Parking Lot Lighting = 16kW	• Exterior Bldg. Lighting = 1kW • Parking Lot Lighting = 16kW
Schedules		
Occupancy, Lighting, & Equipment	Monday through Friday: 6am – 7am = 15% 7am – 8am = 60% 8am – 6pm = 100% 6pm – 7pm = 50% 7pm – 8pm = 10%	Monday through Friday: 6am – 7am = 15% 7am – 8am = 60% 8am – 6pm = 100% 6pm – 7pm = 50% 7pm – 8pm = 10%
HVAC	Monday through Saturday 5am – 9pm	Monday through Saturday 5am – 9pm

	Building Design (Design Energy Cost Case)	ASHRAE 90.1-1999 Prescriptive Requirements (Energy Cost Budget Case)
Mechanical & Plumbing Systems		
HVAC System Type	• AHU-1 is constant volume, 100% outside air that provides ventilation air to each heat pump w/ a 53% effective energy recovery wheel • Geothermal water-to-water heat pumps serve AHU coil • Geothermal water-to-air heat pumps in all zones • Geothermal well field serves all WSHPs	• AHU-1 is constant volume, 100% outside air that provides ventilation air to each heat pump • Water-to-water heat pumps serve AHU coil • Water-to-air heat pumps in all zones • Cooling tower provides chilled water to WSHP loop • Boiler provides hot water to WSHP loop
Boiler	No boiler	• 80% efficient • Fuel Type = Fuel Oil (See Note c)
Central Plant	• Geothermal well field	• Cooling tower
Heat Pump Efficiency (See Note d)	Geothermal heat pumps (See Note e) Water-to-air heat pumps: • HP-1: EER = 17.4, COP = 3.7 • HP-2: EER = 17.4, COP = 3.7 • HP-3: EER = 16.6, COP = 3.5 • HP-4: EER = 16.2, COP = 3.6 • HP-5: EER = 15.0, COP = 3.4 • HP-6: EER = 15.0, COP = 3.2 • HP-7: EER = 15.0, COP = 3.1 • HP-8: EER = 13.9, COP = 3.1 • HP-9: EER = 13.7, COP = 3.1 • HP-10: EER = 13.4, COP = 3.1 • HP-11: EER = 13.4, COP = 3.1 Water-to-water heat pumps: • WWHP-1, 2, 3, 4: EER = 12.6, COP = 5.0	Water-source heat pumps Water-to-air heat pumps: • HP-1: EER = 11.2, COP = 4.2 • HP-2: EER = 11.2, COP = 4.2 • HP-3: EER = 11.2, COP = 4.2 • HP-4: EER = 11.2, COP = 4.2 • HP-5: EER = 12.0, COP = 4.2 • HP-6: EER = 12.0, COP = 4.2 • HP-7: EER = 12.0, COP = 4.2 • HP-8: EER = 12.0, COP = 4.2 • HP-9: EER = 12.0, COP = 4.2 • HP-10: EER = 12.0, COP = 4.2 • HP-11: EER = 12.0, COP = 4.2 Water-to-water heat pumps: • WWHP-1, 2, 3, 4: EER = 16.6, COP = 6.1

	Building Design (Design Energy Cost Case)	ASHRAE 90.1-1999 Prescriptive Requirements (Energy Cost Budget Case)
Mechanical & Plumbing Systems, continued		
HVAC Circulation Loop Properties	• WSHP loop is constant flow	• WSHP loop is constant flow
Domestic Water Heating	Program not able to model	Program not able to model

Notes:

a) Each individual space in the DEC case does not need to have a lighting power density less than the ECB case. The overall lighting power density for the DEC case needs to be less than the ECB case.
b) Unregulated Loads
c) The Carrier HAP v4.2a program has a flaw that causes the boiler energy input for a WSHP system to be reported as zero if the fuel source is propane. To work around this error, the boiler was defined with a fuel source of fuel oil. The fuel rates for this fuel source were then defined the same as the Dakota Sioux Propane commercial rate for propane fuel. This allowed the program to correctly report the energy use by the boiler and the associated energy costs.
d) Each individual zone heat pump in the DEC case does not need to have an efficiency less than the ECB case in order to comply with ASHRAE 90.1-1999. The overall HVAC system efficiency needs to be less than the ECB case.
e) Heat pump efficiencies are based on the submitted and approved shop drawings from Water Furnace.

Replacement Health Center, Sisseton, SD

Energy Summary by End Use

End Use	Regulated?	Energy Type	Proposed Building Energy [kWh]	Proposed Building Peak [kWh]	Budget Building Energy [kWh]	Budget Building Peak [kWh]	Optimized Energy [%]
Lighting - Conditioned	x	Electricity	309,710		331,151		94%
Lighting - Unconditioned							
Space Heating	x	Electricity	64,594		490,554		13%
Space Cooling	x	Electricity	245,611		280,904		87%
Pumps	x	Electricity	603,559		603,559		100%
Heat Rejection	x	Electricity	0		22,899		0%
Fans - Interior Ventilation	x	Electricity	162,730		162,730		100%
Fans - Interior Exhaust	x	Electricity	50,468		50,468		
Fans - Terminal Unit	x	Electricity	60,502		63,487		
Fans - Parking Garage							
Service Water Heating							
Office Equipment		Electricity	27,950		27,950		100%
Exterior Lighting		Electricity	73,221		73,221		100%
TOTAL BUILDING CONSUMPTION			**1,598,345**		**2,106,923**		**76%**
TOTAL REGULATED BUILDING CONSUMPTION			**1,497,174**		**2,005,752**		**75%**

Energy and Cost Summary by Fuel Type

Type	DEC" Use [kWh]	DEC" Cost [$]	ECB' Use	ECB' Cost [$]	DEC" / ECB' Energy %	DEC" / ECB' Cost %
NONRENEWABLE (REGULATED + UNREGULATED)						
Electricity (Total)	1,598,345	$ 38,422	2,106,923	$ 55,029	76%	70%
Other	-	$ -	-	$ -	-	-
Total Nonrenewable (Regulated + Unregulated)	1,598,345	$ 38,422	2,106,923	55,029	76%	70%

Type	DEC" Use [kWh]	DEC" Cost [$]	ECB' Use	ECB' Cost [$]	DEC" / ECB' Energy %	DEC" / ECB' Cost %
NONRENEWABLE (REGULATED ONLY)						
Electricity (Total)	1,497,174	$ 35,990	2,005,752	$ 52,597	75%	68%
Other	-	$ -	-	$ -	-	-
Total Nonrenewable (Regulated Only)	1,497,174	$ 35,990	2,005,752	52,597	75%	68%

Percent Savings = (ECB' $ -DEC" $)/ECB' $ = 32%

Monthly Simulation Results for ASHRAE 90.1 SYSTEM

Project Name: Sisseton Energy Model
Prepared by: Leo A Daly

12/13/2005
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Air System Simulation Results (Table 1) :

Month	WSHP Cooling Coil Load (kWh)	WSHP Eqpt Cooling Load (kWh)	WSHP Clg Compressor (kWh)	WSHP Heating Coil Load (kWh)	WSHP Eqpt Heating Load (kWh)	WSHP Htg Compressor (kWh)	Humidifier Load (kg)
January	63376	63376	15636	172975	171136	22493	79137
February	60731	60731	16089	148638	146983	18941	70150
March	65294	65294	18570	122329	122128	15625	60607
April	41994	41994	13611	18844	18791	3508	33489
May	67071	67071	21490	6858	6858	1311	9984
June	99851	99851	31357	974	974	185	279
July	142001	142001	42793	153	153	28	0
August	126396	126396	38241	362	362	68	0
September	75095	75095	23753	4802	4802	913	12144
October	77741	77741	24751	57683	57683	7164	32152
November	59789	59789	18217	96381	96381	12415	48554
December	65750	65750	16409	170882	169789	22184	82485
Total	**945089**	**945089**	**280915**	**800880**	**796040**	**104835**	**428981**

Air System Simulation Results (Table 2) :

Month	Humidifier Input (kWh)	Ventilation Fan (kWh)	Exhaust Fan (kWh)	Terminal Fan (kWh)	Cooling Tower Fan (kWh)	WSHP Loop Water Pump (kWh)	Boiler Output (kWh)
January	0	13339	4138	5295	196	51263	76336
February	0	12805	3972	5025	293	46302	58741
March	0	13872	4303	5409	602	51263	44773
April	0	13339	4138	5175	1643	49610	9071
May	0	13872	4303	5383	2514	51263	3111
June	0	13339	4138	5180	3461	49610	230
July	0	13872	4303	5395	4709	51263	0
August	0	13872	4303	5392	4251	51263	32
September	0	13339	4138	5180	2670	49610	2103
October	0	14406	4469	5586	1696	51263	11302
November	0	12805	3972	5001	662	49610	32572
December	0	13872	4303	5465	203	51263	69192
Total	**0**	**162730**	**50479**	**63485**	**22900**	**603584**	**307462**

Air System Simulation Results (Table 3) :

Month	Boiler Input (kWh)	Boiler Misc. Electric (kWh)	Lighting (kWh)	Electric Equipment (kWh)
January	95419	347	27532	2323
February	73427	267	26126	2206
March	55967	203	27532	2323
April	11339	41	27469	2319
May	3889	14	27532	2323
June	287	1	27469	2319
July	0	0	28751	2427
August	39	0	27532	2323
September	2628	10	27469	2319
October	14128	51	29969	2531
November	40714	148	25032	2111
December	86490	314	28751	2427
Total	**384327**	**1396**	**331165**	**27952**

Energy Budget by System Component - BASE CASE

Sisseton Energy Model
Leo A Daly

12/13/2005
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1. Annual Coil Loads

Component	Load (kWh)	(kWh/m²)
Cooling Coil Loads	945,089	144.994
Heating Coil Loads	1,093,239	167.723
Grand Total	**2,038,328**	**312.717**

2. Energy Consumption by System Component

Component	Site Energy (kWh)	Site Energy (kWh/m²)	Source Energy (kWh)	Source Energy (kWh/m²)
Air System Fans	276,684	42.448	988,158	151.601
Cooling	280,904	43.096	1,003,227	153.913
Heating	490,554	75.260	763,709	117.167
Pumps	603,559	92.597	2,155,568	330.703
Cooling Towers	22,899	3.513	81,783	12.547
HVAC Sub-Total	**1,674,600**	**256.914**	**4,992,445**	**765.932**
Lights	331,151	50.805	1,182,682	181.445
Electric Equipment	27,950	4.288	99,823	15.315
Misc. Electric	73,221	11.233	261,504	40.119
Misc. Fuel Use	0	0.000	0	0.000
Non-HVAC Sub-Total	**432,322**	**66.326**	**1,544,008**	**236.879**
Grand Total	**2,106,923**	**323.240**	**6,536,453**	**1002.811**

Notes:
1. 'Cooling Coil Loads' is the sum of all air system cooling coil loads.
2. 'Heating Coil Loads' is the sum of all air system heating coil loads.
3. Site Energy is the actual energy consumed.
4. Source Energy is the site energy divided by the electric generating efficiency (28.0%).
5. Source Energy for fuels equals the site energy value.
6. Energy per unit floor area is based on the gross building floor area.
   Gross Floor Area ______ **6518.1** m²
   Conditioned Floor Area ______ 6518.1 m²

Energy Budget by Energy Source - BASE CASE

Sisseton Energy Model
Leo A Daly

12/13/2005
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1. Annual Coil Loads

Component	Load (kWh)	(kWh/m²)
Cooling Coil Loads	945,089	144.994
Heating Coil Loads	1,093,239	167.723
Grand Total	**2,038,328**	**312.717**

2. Energy Consumption by Energy Source

Component	Site Energy (kWh)	Site Energy (kWh/m²)	Source Energy (kWh)	Source Energy (kWh/m²)
HVAC Components				
Electric	1,290,255	197.949	4,608,054	706.959
Natural Gas	0	0.000	0	0.000
Fuel Oil	384,327	58.963	384,327	58.963
Propane	0	0.000	0	0.000
Remote Hot Water	0	0.000	0	0.000
Remote Steam	0	0.000	0	0.000
Remote Chilled Water	0	0.000	0	0.000
HVAC Sub-Total	**1,674,582**	**256.911**	**4,992,381**	**765.922**
Non-HVAC Components				
Electric	432,331	66.327	1,544,038	236.884
Natural Gas	0	0.000	0	0.000
Fuel Oil	0	0.000	0	0.000
Propane	0	0.000	0	0.000
Remote Hot Water	0	0.000	0	0.000
Remote Steam	0	0.000	0	0.000
Non-HVAC Sub-Total	**432,331**	**66.327**	**1,544,038**	**236.884**
Grand Total	**2,106,913**	**323.239**	**6,536,419**	**1002.806**

Notes:
1. 'Cooling Coil Loads' is the sum of all air system cooling coil loads.
2. 'Heating Coil Loads' is the sum of all air system heating coil loads.
3. Site Energy is the actual energy consumed.
4. Source Energy is the site energy divided by the electric generating efficiency (28.0%).
5. Source Energy for fuels equals the site energy value.
6. Energy per unit floor area is based on the gross building floor area.
   Gross Floor Area ____________ 6518.1 m²
   Conditioned Floor Area ____________ 6518.1 m²

Monthly Simulation Results for Ground-Cpld W.S. Heat Pumps

Project Name: Sisseton Energy Model
Prepared by: Leo A Daly

12/13/2005
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Air System Simulation Results (Table 1) :

Month	WSHP Cooling Coil Load (kWh)	WSHP Eqpt Cooling Load (kWh)	WSHP Clg Compressor (kWh)	WSHP Heating Coil Load (kWh)	WSHP Eqpt Heating Load (kWh)	WSHP Htg Compressor (kWh)	WSHP Aux Htg Load (kWh)
January	64081	64081	12280	80601	80598	14191	3
February	61733	61733	11831	66815	66813	11552	2
March	66664	66664	14236	50461	50461	8469	0
April	42037	42037	10018	15537	15446	4177	91
May	66314	66314	17529	5647	5643	1521	4
June	97598	97598	28480	731	731	196	0
July	137281	137277	43997	112	112	30	0
August	122850	122845	39478	227	227	60	0
September	74131	74131	21304	3997	3997	1060	0
October	79134	79134	20089	17736	17736	2853	0
November	61129	61129	13636	38361	38361	6561	0
December	66491	66491	12743	78831	78828	13825	2
Total	939444	939435	245621	359057	358955	64494	102

Air System Simulation Results (Table 2) :

Month	WSHP Aux Htg Input (kWh)	Humidifier Load (kg)	Humidifier Input (kWh)	Ventilation Fan (kWh)	Exhaust Fan (kWh)	Terminal Fan (kWh)	Vent. Reclaim Device (kWh)
January	3	79137	0	13339	4138	4995	0
February	2	70150	0	12805	3972	4766	0
March	0	60607	0	13872	4303	5152	0
April	91	33489	0	13339	4138	4950	0
May	4	9984	0	13872	4303	5149	0
June	0	279	0	13339	4138	4953	0
July	0	0	0	13872	4303	5154	0
August	0	0	0	13872	4303	5153	0
September	0	12144	0	13339	4138	4954	0
October	0	32152	0	14406	4469	5343	0
November	0	48554	0	12805	3972	4760	0
December	2	82485	0	13872	4303	5172	0
Total	102	428981	0	162730	50479	60502	0

Air System Simulation Results (Table 3) :

Month	WSHP Loop Water Pump (kWh)	Lighting (kWh)	Electric Equipment (kWh)
January	51263	25747	2323
February	46302	24437	2206
March	51263	25747	2323
April	49610	25692	2319
May	51263	25747	2323
June	49610	25692	2319
July	51263	26892	2427
August	51263	25747	2323
September	49610	25692	2319
October	51263	28037	2531
November	49610	23402	2111
December	51263	26892	2427
Total	603584	309723	27952

Selected Charts, Figures, and Calculations in Reference to EA2 – Onsite Renewable Energy

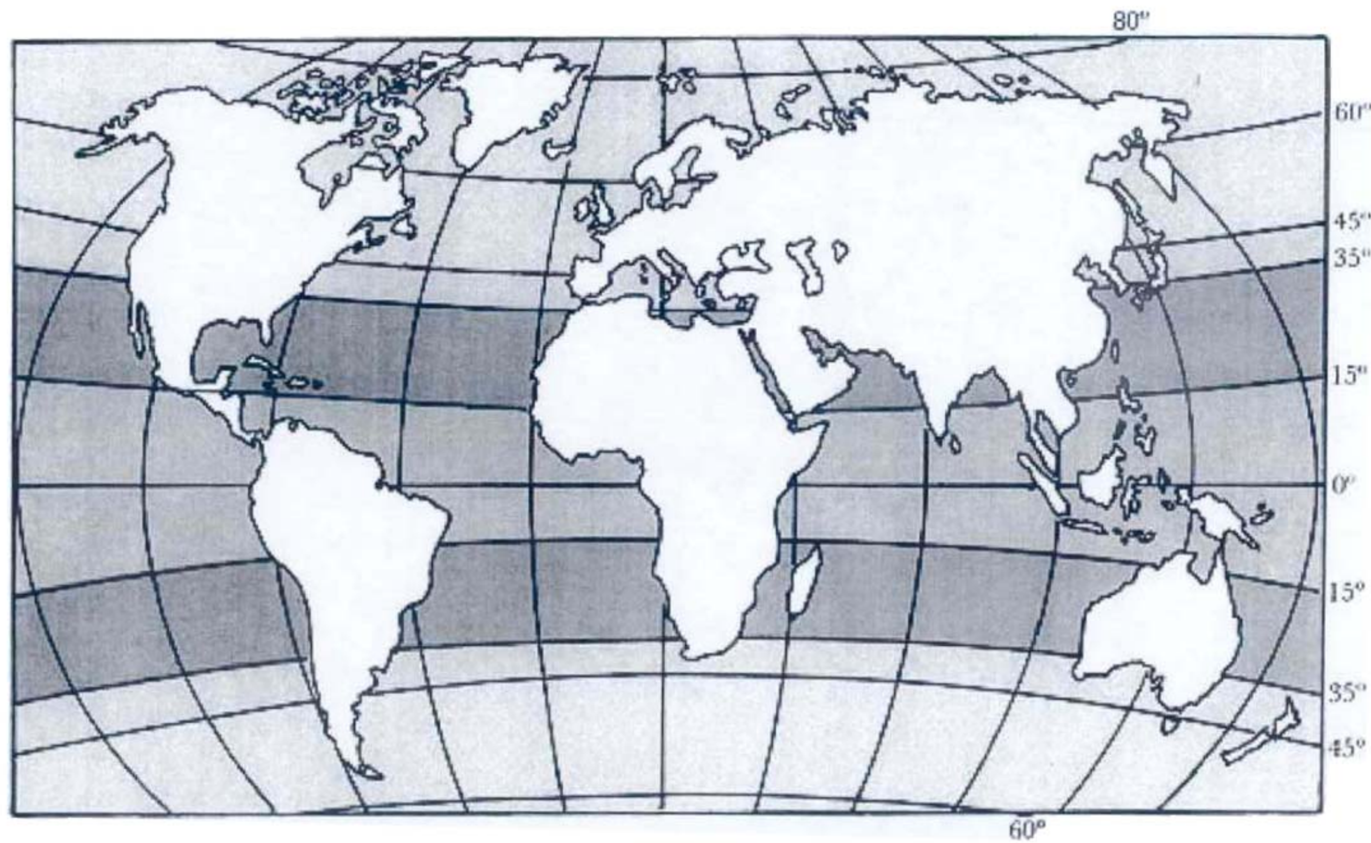
COST OF RENEWABLE ENERGY SYSTEMS - SPREADSHEET No. 1

RENEWABLE ENERGY SOURCE	DESCRIPTION	INSTALLATION SIZE IN KWp	COST \$ PER Wp (t.k.)	COST \$ PER kWH	APPLICATIONS IN IHS BLDGS.	ENVIRONMENTAL BENEFITS	ECONOMIC INCENTIVES
Rooftop fixed Photovoltaic Systems Economic life of modules is 30 years. In the CONUS, PV systems work best for places within latitudes between 15° N and 45° N (See Map)	Involves arrays of photovoltaic modules mounted on flat roof spaces unobstructed by other equipment. Each module is made of silicon cells that convert the solar energy of the sun directly into electricity. Visual Impact: For buildings, the roof top area needed to install photovoltaic modules is about 20 sq-meter/kW.	1 – 100 100-250 250-500	9 7.5 6 Very Low O&M Note: With sun tracking System, Costs Equal BIPV costs	20-40 ¢ " "	A PV System connected to power grid through net metering can offset utility peak demand charges. In IHS bldgs it can power indoor and outdoor lights, and other bldg loads not connected to critical or life safety branches i.e.: PCs, battery chargers, parking areas, water pumps, perimeter of bldgs, etc	One kW of photovoltaic energy can reduce up to 2,300 kgr of yearly CO_2 emissions from the burning of fossil fuels.	There are federal and state economic incentives that promote the installation and use of both rooftop and BIPV photovoltaic solar energy systems. Most of these economic incentives are provided in the form of tax exemptions, rebates and refunds.
Building Integrated Photovoltaic Systems, BIPV	Photovoltaic modules are integrated as architectural elements of the bldg. BIPV is placed in skylights, windows, awnings, and other vertical and sloped portions of the bldg envelope such as fenestration or façade elements. BIPV is so complete that the appearance and traditional functionality of the aforementioned elements is not compromised but enhanced.	Same as above	1.5 to 2 times the dollar figures per Wp given above. Very Low O&M	Ditto	Same as above.	Same environmental benefits as mentioned above.	Special economic incentives are given to projects that serve Native American populations. Using the federal and state governments incentives it is possible to reduce the given t.k. costs of photovoltaic installation systems up to 15%
Wind Turbines Suitable cost-effective sites need 5 m/s (11 mph) winds for small power grid connected systems	They are packaged systems that include the rotor, generator, turbine blades, and drive.	10 – 250	1.5 to 3 Medium O&M	5 – 10 ¢	Interconnection of small wind turbines with utility power is currently under research. These systems work better as stand alone systems.	We don't have yet a quantifiable environmental benefit for this renewable technology. However, it is fair to say that they can also be used to reduce CO_2 gas emissions.	Wind turbines also have both government and state economic incentives to use wind as a renewable energy resource.

COST OF RENEWABLE ENERGY SYSTEMS - SPREADSHEET No. 2

RENEWABLE ENERGY SOURCE	DESCRIPTION	INSTALLATION SIZE IN KWp	COST \$ PER kW (t.k.)	COST \$ PER kWH	APPLICATIONS IN IHS BLDGS.	ENVIRONMENTAL BENEFITS	ECONOMIC INCENTIVES
Geothermal Energy Is homegrown energy that reduces the US dependency on foreign oil. In a cost-effective plant, the Geothermal fluid temperature should be between 210 and 300 degrees F. GT plants require additional water sources. 400 to 650 gpm for a 1 MW plant.	Consists of almost unlimited amount of heat generated by the earth's core. Geothermal energy is available 24 hours a day, 365 days. It has 95% availability compared to 75% availability of coal plants. Is energy available in hydrothermal resources. However is energy that can be tapped almost anywhere by means of geothermal heat pumps. These pumps are easily integrated into bldgs or communities with almost no visual impact on them	< 1 MW	3,000 to 5,000 Medium O&M	0.05	A geothermal power plant between 0.5 and 1 MW would probably cover all the power needs of an IHS bldg.	Geothermal fields produce only about one-sixth of the carbon dioxide that a relatively clean natural-gas-fueled power plant produces, and very little if any, of the nitrous oxide or sulfur-bearing gases. Binary plants, which are closed cycle operations, release essentially no emissions.	Federal economic incentives from DOE Also special aid for Native American Communities.
Low-impact Hydro	Hydroelectric power captures the kinetic energy of water as it moves from a higher to a lower elevation then passing it through a turbine.	Microhydro – up to 100 kW Minihydro – 100 kW to 1,5 MW Small Hydro – 1.5 kW to 30 MW	8,000 Low O&M	0.07	A minihydro power plant between 100 kW and 1.5 MW would probably cover all the power needs of an IHS bldg.	No CO_2 nor NO_x emissions	Same as above
Biomass plants burn biological material such as wood processing residues and also agricultural residues such as pits, shells, stacks and prunings.	Biomass plants also burn municipal waste and methane gas from waste land fills.	Fuel access is the key financial variable for biomass-based electricity. Average plant capacity produces 20 MW	? High O&M	0.06 to 0.09	A biomass plant would be too big for an IHS bldg.	Biomass burning emits SO_x NO_x also CO and particles. However gas concentrations are a lot less than burning coal or other fossil fuels.	Same as above
Biogas is produced when certain bacteria de-compose organic matter by anaerobic digestion	Gases produced are CH_4, NH_3, SO_2, H_2S. Methane can be used for heating or to produce electricity.	Cost-effective plants require at least the manure from 400 dairy cows.	Digesters cost between 400 and 1,000 per cow High O&M	0.10	Same as above	Methane gas is a renewable energy source	Same a above

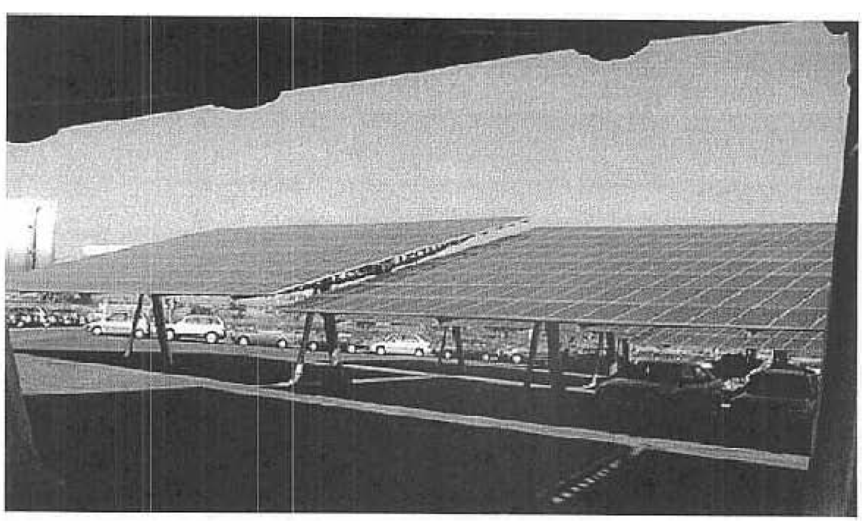
Solar Radiation vs Latitud



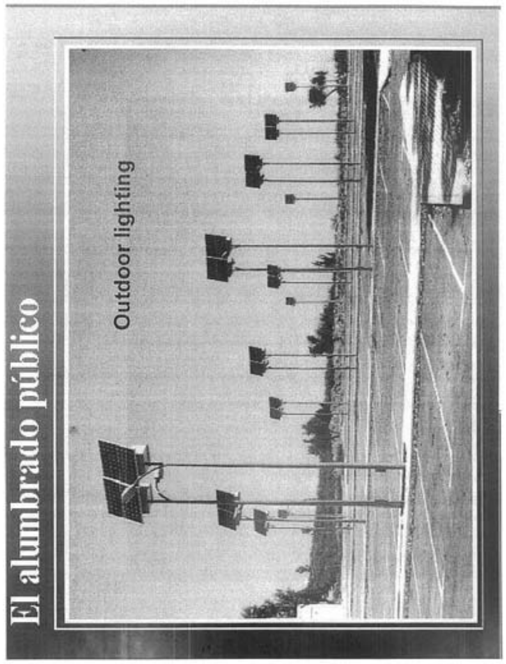
PV ROOFTOP APPLICATIONS

Fig. 2. PV installation by PowerLight for Target Corporation in Southern California (image supplied by PowerLight).

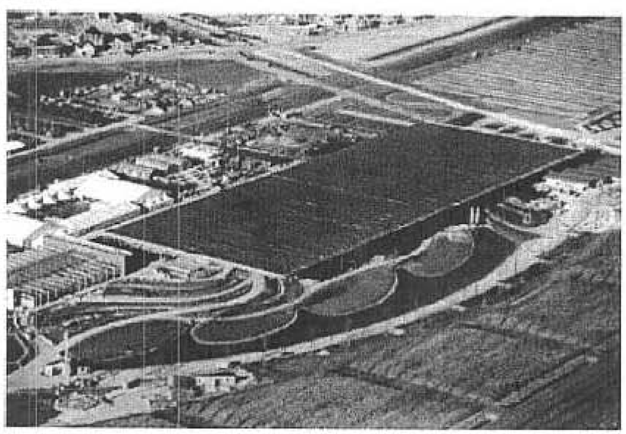
Installers Laying Tiles on the Rooftop



Photovoltaic Modules on Car Parking Lot



BIPV ROOF INTEGRATION EXAMPLES



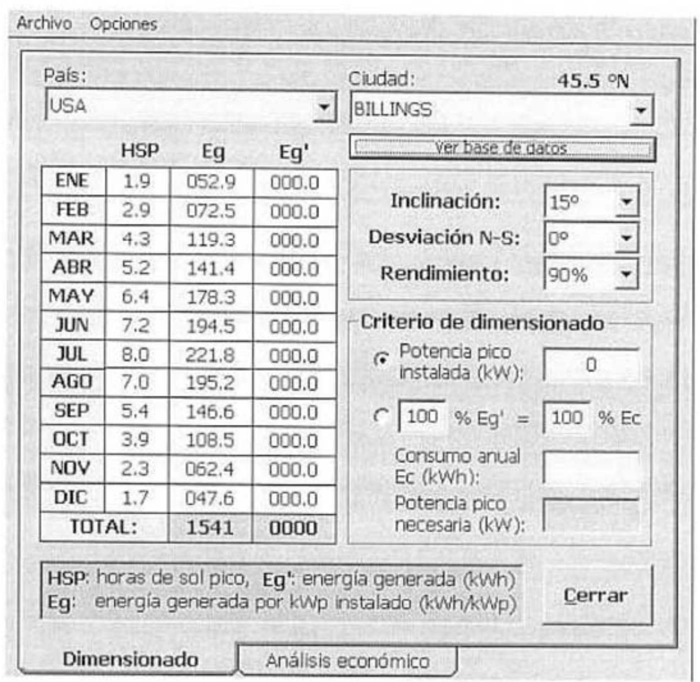
DESIGNING RENEWABLE ENERGY SYSTEMS FOR THE SISSETON CLINIC IN SOUTH DAKOTA.

. Find existing renewable energy sources existing in Sisseton.

There are wind and solar energy sources. There are no geothermal, low-impact hydro, nor biomass or bio-gas sources.

The average wind speed in South Dakota is11 mph and could be used on a stand alone wind turbine. However, we need to provide a renewal energy system that could work reliably interconnected with the existing utility power provider.

Choose Solar Photovoltaic: Find Latitude of Sisseton. Notice that in the attached Map this latitude is in the 45° N band of latitudes. There is no readily available solar energy data for Sisseton but we could use similar data that is available for Billings, a location of similar latitude. We enter data in a computer program and come up with the number of Peak Solar Hours for Billings (read as Sisseton). See computer program print out.



Archivo Opciones

País: USA

Ciudad: BILLINGS 45.5 °N

Ver base de datos

	HSP	Eg	Eg'
ENE	1.9	052.9	000.0
FEB	2.9	072.5	000.0
MAR	4.3	119.3	000.0
ABR	5.2	141.4	000.0
MAY	6.4	178.3	000.0
JUN	7.2	194.5	000.0
JUL	8.0	221.8	000.0
AGO	7.0	195.2	000.0
SEP	5.4	146.6	000.0
OCT	3.9	108.5	000.0
NOV	2.3	062.4	000.0
DIC	1.7	047.6	000.0
TOTAL:		1541	0000

Inclinación: 15°

Desviación N-S: 0°

Rendimiento: 90%

Criterio de dimensionado

Potencia pico instalada (kW): 0

100 % Eg' = 100 % Ec

Consumo anual Ec (kWh):

Potencia pico necesaria (kW):

HSP: horas de sol pico, Eg': energía generada (kWh)
Eg: energía generada por kWp instalado (kWh/kWp)

Cerrar

Dimensionado | Análisis económico

2. Look up the information in Spread Sheet 1. Solar seems a more reliable type of renewable energy than wind, therefore choose a Rooftop Photovoltaic System,

with modules inclined 15 degrees, and oriented to the magnetic South. This system is to be connected to the local utility power grid at Sisseton.

3. What would be the electrical loads that will be powered by the Solar Photovoltaic System to be installed at the Sisseton Clinic?
   It seems appropriate to apply this renewable energy source to the outdoor lights which are not part of the critical or life safety loads of the Sisseton clinic.

4. How much load are the outdoor lights?
   We find this information in the Sisseton 100% Contract Documents – Design Booklet, Tab 6, Panel Calcs, and Page 2 of 8. Electrical Power Panel HSL which has been designed by the A/E for the Site Lights includes electrical lights for the following: streets, parking area, bldg exterior and canopy. The total load is 26,350 Watts.

5. Applying a 25% fudge factor, the found load becomes 33,000 Watts = 33 kWp

6. Entering this value in the computer program we get the following results:

Archivo Opciones

País: USA

Ciudad: BILLINGS 45.5 °N

Ver base de datos

	HSP	Eg	Eg'
ENE	1.9	052.9	1744.4
FEB	2.9	072.5	2391.7
MAR	4.3	119.3	3936.3
ABR	5.2	141.4	4667.5
MAY	6.4	178.3	5883.2
JUN	7.2	194.5	6419.4
JUL	8.0	221.8	7320.1
AGO	7.0	195.2	6442.9
SEP	5.4	146.6	4836.3
OCT	3.9	108.5	3580.8
NOV	2.3	062.4	2059.4
DIC	1.7	047.6	1571.5
TOTAL:		1541	5.09E+4

Inclinación: 15°

Desviación N-S: 0°

Rendimiento: 90%

Criterio de dimensionado

Potencia pico instalada (kW): 33

100 % Eg' = 100 % Ec

Consumo anual Ec (kWh):

Potencia pico necesaria (kW):

HSP: horas de sol pico, Eg': energía generada (kWh)
Eg: energía generada por kWp instalado (kWh/kWp)

Cerrar

Dimensionado | Análisis económico

7. That is, the calculated photovoltaic system would generate 50,900 kWh of electrical energy per year. At an average cost of $ 0.07/kWh, the savings in energy costs for the Sisseton clinic would be $ 3,563 per year. Looking up on

Tab E of the document Design Development Submittal for Sisseton, we find that the Estimated Annual Energy Costs are \$ 35,710 per year. Then, \$ 3,563 per year represents about 10% in energy savings for the Sisseton Clinic using a rooftop photovoltaic system. (This result could gain a couple of LEED points for Sisseton in the Renewable Energy Credits of the Energy & Atmosphere Section.)

8. How much would the 33 kWp system cost?

The total budget for both the indoor and outdoor lighting systems designed for Sisseton is \$ 476,500. One third of it would be the cost of outdoor lights (\$ 158,667).

Using the cost figures given in Spreadsheet 1, the Turn Key Cost of 33kW of photovoltaic would be \$297,000. This cost can be reduced in 15% or more by applying the economic incentives given by the federal and state governments for installing photovoltaic systems in South Dakota. Therefore, the estimated cost of the 33 kW photovoltaic systems would be: \$ 297,000 - \$44,550 = \$252,450

The percent increment in cost on the original budget for outdoor lights would be: {(\$252,450 - \$158,667)/\$ 158,667} x 100 = 59%

9 How much rooftop area the photovoltaic modules would occupy?

{(20 sq-meter)/kW} x 33 kW = 660 sq-meters of rooftop space.

Sisseton's rooftop area is about 8,000 sq-meters; therefore, it can provide adequate space for the photovoltaic modules.

10. What would be the benefits of installing the proposed power grid connected photovoltaic system at the Sisseton Clinic?

- Environmental benefits: reduction of green house effect gases into the atmosphere.
  (2,300 kgr of CO_2 /kW -year) x (33 kW) = 75,900 kgr of less CO_2 emission per year.

- Economic benefits: Energy savings: \$ 3,563/year

- It would facilitate compliance with mandatory energy conservation goals stated in the Energy Policy Act of 2005: An expandable photovoltaic system would allow the Sisseton Clinic to add more modules as needed to incorporate, yearly, additional non critical non life safety electrical loads to comply with the 2% per year energy conservation goals mandated by the Energy Policy Act of 2005.
- A PV system can help the Sisseton Clinic to gain renewable energy points for LEED certification of its building.

LEO A DALY PLANNING ARCHITECTURE ENGINEERING INTERIORS	PROJECT TITLE SISSETON HEALTH CLINIC SUBJECT PANEL CALCULATIONS	COMPUTED FLE CHECKED	PROJECT NUMBER 010402 DATE 12-31-03 PAGE 2 OF 8 PAGES

PANEL LLS: EQUIP = 12,312 W X100% = 12,312 W

PANEL H4LS: (EMERG)

LIGHTS = 6,615 W X1.25% = 8,269 W

(NORMAL)

LIGHTS = 2,170 W X1.25% = 2,712 W

PANEL H1LS: (EMERG)

LIGHTS = 5929 W X1.25% = 7,411 W

(NORMAL)

LIGHTS = 1,858 W X1.25% = 2,322 W

EQUIP = 12,312 W X 100% = 12,312 W

PANEL HLS: (EMERG)

LIGHTS = 3108 + 6,615 + 5929 = 15,652 W X1.25 = 19,565 W

(NORMAL)

LIGHTS = 3108 + 2170 + 1,858 = 7,136 W X1.25 = 8,920 W

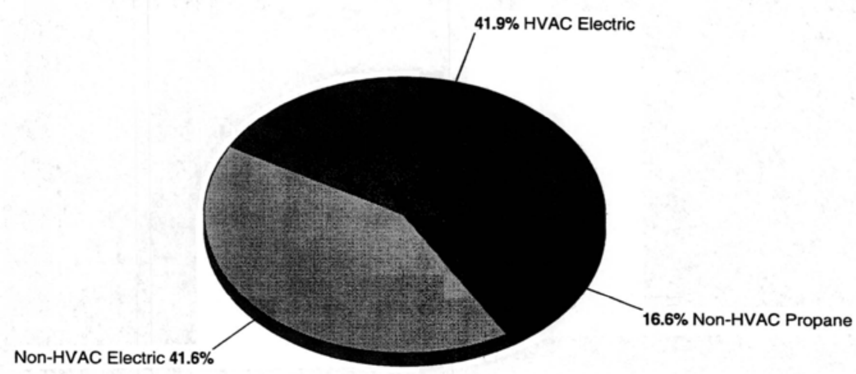
EQUIP = 12,312 W X 100% = 12,312 W

⇒ PANEL HSL: LIGHTS = 26,350 X1.25% = 32,936 W

PANEL HSEQ: EQUIP = 83,100 + 80,000 = 163,100 W X100% = 163,100 W

LEO A DALY FORM NO. 6

Annual Energy Costs - Sisseton BLOCK Load



1. Annual Costs

Component	Annual Cost ($/yr)	($/m²)	Percent of Total (%)
HVAC Components			
Electric	14,946	1.861	41.9
Natural Gas	0	0.000	0.0
Fuel Oil	0	0.000	0.0
Propane	0	0.000	0.0
Remote Hot Water	0	0.000	0.0
Remote Steam	0	0.000	0.0
Remote Chilled Water	0	0.000	0.0
HVAC Sub-Total	**14,946**	**1.861**	**41.9**
Non-HVAC Components			
Electric	14,847	1.849	41.6
Natural Gas	0	0.000	0.0
Fuel Oil	0	0.000	0.0
Propane	5,917	0.737	16.6
Remote Hot Water	0	0.000	0.0
Remote Steam	0	0.000	0.0
Non-HVAC Sub-Total	**20,764**	**2.586**	**58.1**
Grand Total	**35,710**	**4.447**	**100.0**

Note: Cost per unit floor area is based on the gross building floor area.

Gross Floor Area .... **8031.0** m²
Conditioned Floor Area .... **746.1** m²